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Editorial

Pacific University Journal of Science and Technology (PUJST) is an international, multidisciplinary, peer-reviewed, biannual research publication of Pacific Academy of Higher Education and Research University, Udaipur (Rajasthan), India. It is with much pleasure that we announce the launch of this journal with the publication of its inaugural issue. On behalf of the editorial team, I would like to extend a very warm welcome to the readers of this journal.

Barely a fraction of the new millennium has passed and we have witnessed significant and astonishing scientific and technological changes around us. As researchers, we are committed to exploring the ways to harness the power of science and technology and meet the real world challenges. Innovations in science and technology are essential for global human benefits and continuous research & development is needed to improve human efficiency in all spheres of life. In the light of the importance of science and technology in human life today, there is a need for rapid dissemination of high quality researches on how advances in science and technology can help us meet the challenges of the new millennium. With this aim in view, ***Pacific University Journal of Science and Technology*** provides a forum for exchange of information on recent and on-going researches in the various fields of science and technology.

The journal shall publish original, research-based, empirical, applied or conceptual papers, articles and reviews on the various aspects and areas of science and technology.

The scope of PUJST includes a wide spectrum of subjects: Agricultural and Biological Sciences, Engineering and Industrial research, Environmental Science, Pure and Applied Mathematics, Physics, Chemistry, and Bio-engineering, to name a few. However, researches and studies in any of the various fields of science and technology are welcome.

I thank the authors, members of the editorial team and reviewers for their efforts in giving shape to this journal. An enormous amount of work has been done to develop this journal, and I trust you will find the efforts reflected in this issue as well as the forthcoming issues.

Finally, we hope that the journal will provide new insights into the world of science and technology and encourage enthusiastic response from the scientific community across the world. We welcome feedback and suggestions for improvement of the journal.

With Regards,

Prof. Suresh Chandra Ameta
Editor

Terrestrial Quasi Periodic Oscillations in Low Mass X-ray Binary: GX340+0.

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Abstract

Quasi Periodic Oscillation (QPO) of frequency 25±2.1 milli-Hertz is detected in Low mass X-ray source GX340+0 in space observed on dated April 1997 by terrestrial Rossi X-ray Timing Explorer observatory. QPO of GX340+0 showed power of about 100 with quality factor 2 and 3800±45.12 X-ray photons radiated per seconds. The flux below the surface layer produced due to conduction of energy during X-ray bursts pours slowly upward and hence generates stable burning on the surface of neutron star causing an occurrence of milli-Hertz QPO.

Keywords: Quasi Periodic Oscillation, X-ray binaries, GX340+0, Rossi-X-ray-Timing-Explorer

Introduction

The significant contraption for astronomers is the temporal studies which promotes the investigation of the physical properties of celestial compact objects known as neutron star often harbored by low mass X-ray binaries. X-ray binaries are divided into two different classes : (i) High mass X-ray binaries (Mass of companion star > 1 M⊙but ≤ 10 M⊙) and (ii) Low mass X-ray binaries (Mass of companion star ≤ 1 M_Θ, where M_Θ is the mass of sun M_Θ ~1.99 x 1030 kg).[1] There have been two further sub classes (i) Z-sources (ii) atoll sources, usually in Low mass X-ray binaries based on their spectral and timing properties during X-rays evolution.[2] It is reported that Z-sources are more luminous than atoll sources. Color-Color Diagram (CCD) and Hardness Intensity Diagram (HID) have been used to understand the Z-track belonging to groups of bright low mass X-ray binaries.[3]

"With Aerobee rocket Geiger counter detected the GX 340+0 as bright low mass X-ray binaries."[4] Friedman et al.[4] discovered that GX 340+0 harbored probably a neutron star as Z-source with X-ray flux varying completely irregularly in the range $4x10^{-9}$ erg $cm^{-2}s^{-1}$.[5-9] It is noticed that Quasi Periodic Oscillation (QPO) frequency increases with increasing (dm/dt). Accretion rate (dm/dt) of X-ray binaries 10 times of Eddington limit belonging to "Horizontal Branch" (HB) becomes nearly equal to Eddington limit referred to "Flaring Branch" FB. GX5-1[5], SCO-X 1[6], G X17+2[7], Cyg X-2[8] showed kilo-Hertz QPO along various Z-track,. The QPOs have been only detected on near small fraction of FB and close to "Normal Branch"NB.[9]

Jonker et al.[10] studied the GX340+0 and reported very high frequency (kHz) QPOs which was detected with Rossi X-ray Timing Explorer (RXTE). Further they also detected lower QPOs in the frequency of range 247 Hz to 625 Hz while frequency of upper QPOs ranging from 567 Hz to 820 Hz lying along HB. Later in 2000, Jonker et al.[11] studied GX340+0 for a broad component of frequency ranging (9-14) Hz with RXTE lying very close to half of the HB of QPOs. Its rms amplitude was consistent with being constant around ~5%, while its FWHM increased with frequency 7 Hz to 18 Hz.[12] Since GX340+0 belongs to category of low mass X-ray binaries and having observed the companion star with mass less than the Sun maneuver our phenomenal understanding about X-ray binaries which led us to believe that source should have QPOs of milli-Hertz frequency.[13] We revisited the archive data and analysis provided detection of milli-Hertz QPOs as reported in this present paper.

Observations and Data Analysis

In order to observe temporal activity of celestial compact X-ray binaries specifically in the present study of Low mass x-ray source GX340+0, the Rossi X-ray Timing Explorer (RXTE) satellite was used. On board All Sky Monitor (ASM) was sensitive in "1.5-12 keV energy spectrums"[14] and was used for observations of bright low mass X-ray binary GX340+0 at different points of time. The observations were taken from 1996 January 06 (02:42:17.2) to 2011 August 31 (00:41:59.6). ASM light curve of GX340+0 obtained from RXTE/ASM from one day averaged dwell data as dated above is shown in Figure 1.

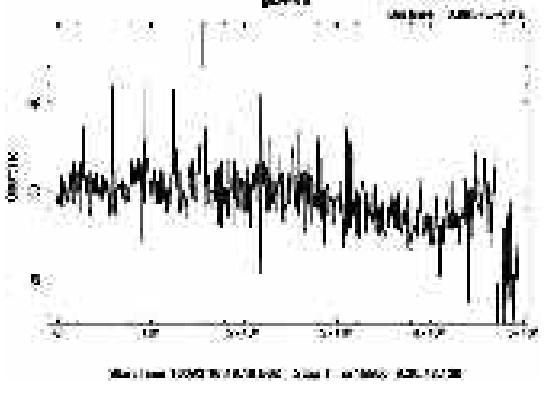

Figure 1: RXTE/ASM one day averaged light curve of Z-source GX340+0 in energy spectrum 1.5-12 keV from 1996 January 06 to 2011 August 31

Initially four major outbursts were detected and one of them was filtered for QPOs feature investigations as given in Figure 2.

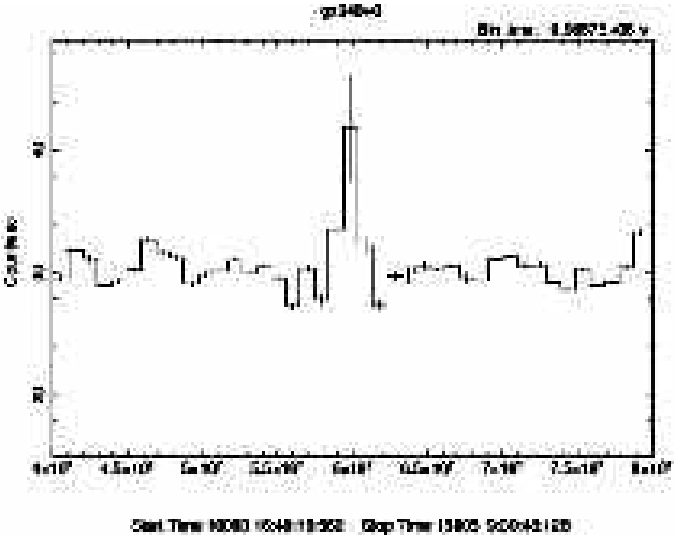

Figure 2: RXTE/ASM light curve of X-ray binary bright source GX340+0 shows first outburst during October-December 1997

Major outburst was detected with 47 counts /second in October- December 1997 with the help of PCA on board RXTE consisted of five Xenon filled proportional counters with observable effective area of ~6500 cm^2, with 18% energy resolution at 6 keV and time resolution ~145. Detail of retrieved archival data with RXTE/PCA having observation ID P20054, sub constituent observations is shown in Table 1 below.

Observation ID	Sub observations	Date	Time	Duration	Exposure
P20054	20054-04-01-00	1997-04-17	13:26:20.5	31314	19754

Table 1

Using standard 1b PCA data, we plotted power density spectrum using HEASOFT package (version 6.16) on dated April 1997 (see Figure 3). The power density spectrum (PDS) was traced to detect presence /absence of QPO in frequency range 10^{-3} mHz to 1 Hz. The sharp peak of power density spectrum showed exactly periodic variation but when broader peaks appeared in PDS of Lorentzian shape became the subject of the present research paper. PDS has many features like an energy spectrum.

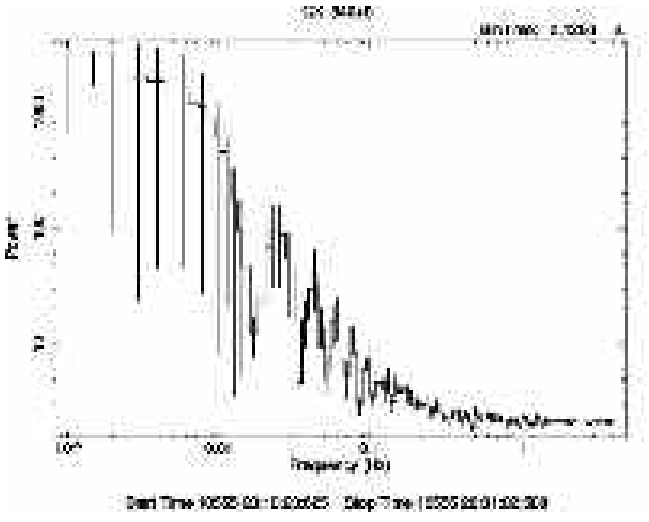

Figure 3: The power density spectrum of Z- source GX340+0 around first burst

PDS obtained from RXTE / PCA observation on 1997 April 17 with bin size 0.125 second is shown in Figure 3. The pulsations and its harmonics are seen at higher frequencies of 25±2.1 mHz, 45±2.3 mHz, 60±2.7 mHz, 75±2.4 mHz, 90±2.9 mHz i.e. multiple of 15 mHz except 25 mHz first peak which may be regarded as a clearly detected QPO present in the power spectrum with quality factor ($\nu_Q/\Delta\nu_Q$) of value around 2 and maximum power of 100.

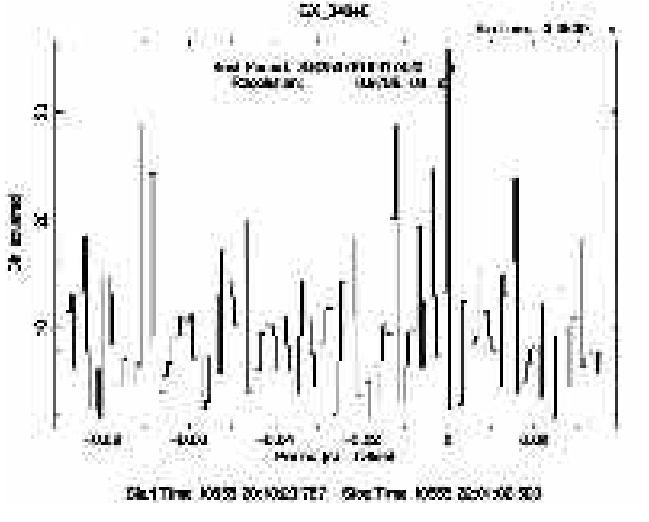

Figure 4: Figure shows best pulse period (3.6253 second with resolution of 0.000976 seconds) of Z-source GX340+0 (ID 20054-04-01-00) for outburst 1997

The pulse period is analyzed and the best estimated value for the pulse period turned out to be 3.6253 second with resolution of 0.000976 seconds for the Z-source GX340+0 having got the sub observed ID 20054-04-01-00 during the outburst 1997. It clearly demonstrates that harbored compact object neutron star spins very fast with frequency of 275.83± 3.67 milli-Hertz.

Results and Discussion

The power density spectra (PDS) for the outbursts is generally obtained in transient source in order to detect the QPO rather than in persistent sources because of bursts persistent luminosity $L_{pers} \leq (0.2\ L_{edd})$. It is very difficult to detect QPO pattern in persistent source[15] because of the fact that the frequency of QPO in number of celestial compact X-ray binaries varies in the range of ~1milli Hertz (mHz) to 40 Hertz[16] due to the non homogeneous distribution of plasmas at the interior of accretion disc. The detection of QPO pattern delivers physical properties of accretion disc, brightness fluctuation of plasmas, radii of accretions disk, spin period of compact object and magnetosphere around neutron stars. We have detected QPO for bright Z-source GX340+0 and analyzed data obtained are shown in Table 2, below:

Outbursts time	Observation ID	QPO Frequency (υ_{QPO})	Pulsations period for spin of neutron star
April 1997	20054-04-01-00	**25±2.1mHz**	3.62537±0.00097 s

Table 2

QPO frequencies υ_{QPO} for outbursts of 1997 is obtained to be 25±2.1 mHz which is within the proposed frequency range of 10^{-3}mHz to 1Hz with pulsations of period of 3.65951 second ($\upsilon_{spin} \leq 273.26$ mHz) of compact neutron star. Often $\upsilon \leq 10^{-3}$ mHz does not exhibit any burst but on the contrary it does when $\upsilon \leq 10^{+3}$ mHz outburst pattern happens. This clearly leads to one believe that QPOs deal with nuclear burning at the surface of compact object.[16] Surface temperature of compact object exhibits fluctuations with constant frequency is the clear reason for this fact. Fluctuations are referred to accretion rate (dm/dt) which fluctuates between stable and unstable burning states.[17] The mHz QPO only occurs if burning fuel rate (dm/dt) ≤ $(dm/dt)_{EDD}$ and if burning fuel fraction varies with time

then it cannot be assumed that complete fuel was burnt during last X-ray bursts.[18]

In beat frequency model ,mHz QPO is regarded as the amount of heat flux in the core of neutron star which develops stable burning.[19] The entire budget of energy of X ray bursts buoyant up slowly in the form flux below the surface of conduction layer and hence generates stable burning on the surface of compact object .Most of thermonuclear bursts and burning on accreting compact object assume that the compact object magnetic field is very weak.[20] This weak field allows tuning beats in the accretion disk . QPO frequency (υ_{QPO}) appears due to beat between spin frequency (υ_{spin}) of compact object and Keplerian frequency ($\upsilon_{keplr.}$) at inner accretion disk. The beat frequency at magnetosphere boundary of compact object [21] is given by

$$\upsilon_{QPO} = \upsilon_{spin} \sim \upsilon_{keplerian} \quad \text{(-1)}$$

In synchronization with this beat frequency, plasma of accretion disk fluctuates and generates QPO in form of the warp. Using the data of $\upsilon_{spin} \leq 275.83 \pm 8.93$ Mhz and υ_{QPO} to be 25±2.1 mHz, we get $\upsilon_{keplerian}$ to be 250.83± 11.03 mHz,. In theory $\upsilon_{keplerian}$ may be expressed as

$$(\upsilon_{keplerian})^2 R^3 = GM_n/4\pi^2 \quad \text{(-2)}$$

where R is radius of orbiting warp produced in accretion disk as a QPO due to fluctuation delivered by beating process between spin of neutron star of mass Mn and Keplerian motion of accreted matter falling from companion star under gravitational pull across Lagrazian point on neutron star.[22] Spin frequency of Low mass X-ray source GX340+0 observed to be 275.83 ± 8.93 mHz which indicates that mass of neutron star is constant according to the principle of conservation of spin angular momentum (I_n 2p υ_{spin}). I_n represents moment of inertia of neutron star. Right hand side of Equation -2 is constant whereas on left hand side, $(\upsilon_{keplerian})^2$ is inversely proportional to R^3. Now estimated values of $\upsilon_{keplerian}$ as 250.83± 11.03 mHz, decides the locations of harbored QPOs in accretion disk towards inner orbiting radius. The closest orbiting QPO would have more temperature as a result of internal friction between particles of accreted matter and hence expectedly would radiate more power (number of X-rays photons emission per seconds represented by area under the peak of QPO) than which is far away from neutron star as shown in the fifth column of Table3.

Outburst year	υ keplerian of QPO	QPO power	Quality factor $\nu_Q/\nu\ \nu_Q$	X-ray photons radiated per seconds
1997	250.83± 11.03 mHz	100±9.6	2	3800±45.12

Table 3

Conclusion

In this piece of research work we discovered milli-Hertz QPOs in the X-ray bursts of years 1997, with observed frequency υ_{QPO} of 25±2.1 mHz in bright Z-source of Low mass X-ray source GX340+0 having quality factor $\nu_Q/\nu\ \nu_Q$ to be 2. The X-rays photons radiated per second by these QPO is observed to be 3800± 45.12, which is justified by the values of radius of the Keplerian orbits where temperature is decided by the inter layer friction between orbiting particles of accreted matter. The size of the radius of Keplerian orbit is inversely proportional to the $(\upsilon keplerian)^{2/3}$ and plasma interaction energy determines the power of QPOs to be 100±9.6. QPO near neutron star delivers more power than which is far apart in accretion disk. Such phenomenon usually is observed in low mass X-rays binaries and harbor most of the time milli-Hertz QPOs. The mHz QPOs occur due to thermonuclear burning on the surface of celestial compact X-ray binaries. The flux below the surface of neutron star produced due to conduction of energy during X-ray bursts pours slowly upward and hence generates stable burning on the surface of compact object. The mHz QPOs appear in weak magnetized X-ray source GX340+0 because strong magnetic field compresses conduction of heat flux below the core of neutron star.

Acknowledgments

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References

1. Alper A, Shahanj J. Nature. 316; 239.
2. Altamirano D, Vander M, Winjnands R, Cumming A. ApJ. 2008; 673:L35.
3. Bildsten L. "Many faces of neutron stars", ed. Buccheri, Paradijs, Alper. (NATO ASZ Serial. Dordecchi kluwer). 1998; C(515): 419.
4. Friedman H, Byram T, Chubb A. Science. 1967; 156: 374.
5. Cornelisse R, Zand M, Verbunt F. A&A. 2003; 405:1033.
6. Dungair R, Jaiswal K, Naik S, Jaaffrey A. MNRAS. 2013; 434:2458-2464.
7. Forman W, Jones C, Cominsky L, Julian P, Murray S, Peters G, Tananbaun H, Giacconi R. Astrophysics. J. suppli. 1978;38:357.
8. Fujimoto Y, Hanawa T, Miyaji S. ApJ. 1981;247:267.
9. Galloway K, Miuno P, Hartman M, Psaltis D, Charkrabraty D. APJS. 2008;179: 360.
10. Jonker G, Wijnands R, Van der klis M. APJL. 1998;499:L191.
11. Jonker G, Van der Klis M, Winjnands R, Homam J, Van J, Mendej M, Ford C, Kuulkers E, Lamb K. ApJ. 200; 537: 374.
12. Hasinger G, Vander M. A & A. 1989;225:79.
13. Joss C, Li K. ApJ. 1980;238:287.
14. Lamb K, Shibazki N, Alpar A, Shaham J. Nature. 1985;317:681.
15. Levine M, Bradt H, Cui W, Jernigan G, Morgan H, Remillard R. ApJ. 1996;469:L33.
16. Market H, Winkler F, Laird N, Clark W, Hearn R, Sprott F, Li k, Bradt V, Lewin G, Schopper W. Astrophysics. J Supplies. 1979;39:573.
17. Psaltis D, Lewin G, Vander M, Computer steller X-Ray sources. Cambridge University Press. Cambridge. 2006:1.
18. Revnivtsev M, Churazov E, Gilfanov M, Sunyaev R. A&A. 2001;372:138.
19. Shirakaw A, Lai D. ApJ. 2002;565:1134.
20. Taam E, ApJ. 1982;258:761.
21. Van Der Klis M, Wijnands D, Van Paradijs J, Lewin G, Lamb K, Vaughan B, Kuulkers E, Psaltis D, Dieters S. IAU Circ. 1996: 6511.
22. Van Der Klis M, Swank H, Zhang W, Jahoda K, Morgan H, Lwin G, Vaughan B, Van Paradijs J. ApJ. 1996 (b);469:L1.

Biochemical Study of Neuroprotective Effects of Asparagus racemosus Root Extract on Stress Induced Neurodegeneration in Swiss Albino Rat Model

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Abstract

Growing data from experimental studies suggest that reactive oxygen species (ROS) plays a key role in various neurological disorders viz. Parkinson's, Alzheimer's disease, stroke, cerebral ischemia and aging. The central nervous system is thus especially vulnerable to free radical damage because of brain's high O_2 consumption, its abundant lipid content and relatively less antioxidant profile. The present work evaluates the neuronal degeneration in specific brain areas due to oxidative stress. Counteracting effects of methanolic root extract of *A. racemosus* was evaluated in swiss albino rat model of stress related neuronal degeneration. Significant results were obtained in this work. LDH and MDA levels were estimated as a marker of stress affiliated neuronal death both necrotic and apoptotic. Both oxidant markers showed a significant increase due to stress treatment. Their value decreased when dose treatment was given to mice. Simultaneously the drug was found to increase the antioxidant level significantly like catalase, ascorbic acid and SOD levels which decrease due to stress treatment. Thus, *A. racemosus* has antioxidative and neuroprotective properties.

Keywords: Oxidative stress, ROS, Brain, Antioxidant, neuroprotective, *Asparagus racemosus*

Introduction

Oxygen, the life supporting element is a known precursor to the formation of pernicious reactive oxygen species (ROS). ROS are mostly oxygen centred radicals which possess unpaired electrons such as superoxide dismutase anion, hydroxyl radical & H_2O_2. ROS can virtually damage any biological entity in its vicinity such as DNA, essential proteins and membrane lipids, carbohydrates and can cause cellular damage.[12] The term "Oxidative stress" is

explained as an imbalance between ROS and antioxidants as opposing forces.[20] Growing data from experimental models and human brain studies suggest that oxidative stress plays an important role in various neurological disorders such as epilepsy, Alzheimer's, Parkinson's disease, stroke, cerebral ischemia, multiple sclerosis[4],& aging.[11] The presence of free radicals within the body can also have a significant role in development and progression of many disease processes like heart disease, congestive heart failure, hypertension, cerebrovascular accidents, liver failure, diabetic complications.[6] The CNS is especially vulnerable to free radical damage because of brain's high oxygen consumption, its abundant lipid content and relative scarcity of antioxidant enzymes as compared to other tissues.[22] "It has been also evidenced that ROS may stimulate extra cellular release of excitatory amino acids"[18] which further worsens the stress induced effects resulting in apoptosis and neuronal death.[7]

The present work was conducted on the brain of Swiss albino rat model to evaluate the biochemical effects of stress. Further, methanolic extract of a herbal drug *Asparagus racemosus* was evaluated for its anti-oxidative properties. Cellular degeneration and cellular injury in brain was estimated. Adaptogenic, antistress, and protective effects of methanolic extract of *A. racemosus* were also studied.

Material and Method

Plant Collection, Identification and Extract Preparation

Fresh roots of *A. racemosus* were collected from botanical garden of the University College of Science, M. L. Sukhadia University, and Udaipur. Plant was identified by Prof. K. G. Ramawat, Head of Department of Botany, M. L. Sukhadia University, Udaipur, India. Roots were air dried at room temperature for 3 weeks. The crushing of the roots was done in laboratory using pestle and mortar, after which it was ground into powder. This powder was packed in high quality filter paper and methanolic extract was prepared by continuous extraction method with the help of soxhlet apparatus. After vacuoevaporation crude extract was dissolved in aqueous medium.

Animals

Adult Swiss albino rats were used for the work. Animals were purchased from Jawahar Lal Nehru Veterinary College, Mhow (M.P) of Body Weight ~150gms. After receiving from supplier, rats were placed for 7 days in an isolated room at controlled conditions of temperature (22 ± 2°C), humidity and light (12 to 12 h night and dark cycle) to minimize the effects of change of place. Rats were kept for breeding as per norms of Centre for prevention and control of use of experimental animals (CPCSEA) India. All experiments were cleared by Institutional Ethical Committee (IAEC). Laboratory is registered with CPCSEA. Prior to the start of the experiments animals were divided into Control & Experimental groups.

Dose Schedule: Rats were given a daily drug extract dose 40mg/Kg of body weight after 11:00AM after stress treatment. Dose was administered daily orally using feeding tube for one month.

Biochemical Analysis

Animals were sacrificed by decapitation. The brain were quickly dissected and placed in ice cold phosphate buffer saline. Tissues were maintained at 4ºC throughout the preparation. Tissues were palpated to remove blood. After cooling down for at least 5 minutes, the brain was dissected on ice chilled glass plates. The brain was divided into cerebral hemispheres. The tissues were weighed and then cold 100mM phosphate buffer pH7.2 was added to them, 10 times dilution was done. Tissues were grounded in a teflon mechanical homogenizer. The homogenate was spun at 10,000 g for 15 minutes and the supernatant was used for enzymatic assay.

All the biochemical estimations were carried out according to established and standardized protocol.

Malondialdehyde (MDA): "MDA, an end product of lipid peroxidation, was measured by using the protocol given by Beuge et al."[5]

Lactate dehydrogenase (LDH): "LDH was assayed in tissue homogenate using a kit." The protocol was given by Z.Biochem[30];Weisshar.D,et al.[21]

Catalase: "Catalase was assayed in tissues

colourimetrically by the method of Sinha.[21]

Ascorbic acid: Ascorbic acid was assayed in tissue homogenate by using the protocol given by Natelson.[15]

Superoxide Dismutase (SOD): SOD was by assayed using the protocol given by Winterbourn et al.[27]

Results

The estimated values give a clear picture of stress induced degeneration and the antioxidative effect of drug extract. The values are shown in enclosed table. In stress group there was a well marked increase in MDA and LDH values as compared to control group.MDA is a marker of apoptotic cell death and LDH is a marker of necrotic cell death. Both these levels rose in the stress group almost 6-10 times the value in the control group. However, the drug treated animals brain shows a marked increase in antioxidant (catalase, ascorbic acid, SOD) levels. The catalase level showed a decrease in the stress group, but it dramatically elevated to 27.5 µ moles of H_2O_2 utilized/min./mg of protein as compared to 11.75 µ moles of H_2O_2 utilized/min./mg of protein in the control group. The Ascorbic acid level measured in mg/100 ml unit showed a marked decrease in the stress group as compared to the control group from 5.44 to 2.7. However, this showed a significant increment to 3.68 in stress + dose group. SOD was measured as percent inhibition of NBT reduction showed a value of 79 in the control group and decreases to 45.48 due to stress treatment but was restored due to dose treatment in stress +dose group showing a significant 67.5 value which is comparable to the control group. In control + dose supplemented group the results were comparable to the control group. The relevant values are exhibited in the enclosed Table 1. The results were estimated as Mean ± SEM with significance 'p' was calculated by student's 't' test.

Discussion

The present work was carried out to accomplish a specific aim to generate the biochemical evidences in favour of stress induced and glucocorticoid mediated

Parameters	Control	Stress	Stress+Dose	Control+Dose
MDA (n moles/ml)	2.05±0.29	13.95±3.75	$4.06\pm0.69^{++++}$	2.77±0.73
LDH (U/L)	9.83±2.79	45.34±5.23	$13.95\pm3.81^{+++}$	2.55±0.41
CATALASE (µ moles of H_2O_2 utilized/min./mg of protein)	11.75±1.46	8.66±2.75	$27.5\pm4.19^{++++}$	11.33±1.59
ASCORBIC ACID (mg/100ml)	5.44±0.77	2.07±0.22	$3.68\pm0.49^{+++}$	3.31±0.57
SOD (% inhibition of NBT reduction)	79.1±0.51	45.48±0.01	$67.12\pm0.26^{\#}$	78.39±0.10

TABLE 1:

Effect of *Asparagus racemosus* wild on various biochemical parameters in brain of control and experimental mice (All values are expressed as Mean±SEM)

@ P<0.05: +
P<0.025: ++
P< 0.01: +++
P<0.005: ++++
P<0.001 : # as compared to stress group.

excitotoxicity and protective effect of *A.racemosus* in brain. Oxidative Stress is an outcome of imbalance between ROS production and antioxidant defences (Catalase, SOD etc.) which in turn evokes a series of events deregulating the cellular functions.[2] "Glucocorticoid contributes to neuronal death by excitotoxicity"[14] which results in pathogenesis of neurodegenerative disorders like "Alzheimer's"[13] "Parkinson's disease."[3,9] Researchers have shown that CNS shows enhanced vulnerability to free radical induced oxidative stress as it is deficient in free radical protection and "uses almost 20% of the total body oxygen"[16] and "this ultimately results in aging."[1,18] "It has been demonstrated by several workers that certain antioxidants including green tea, blueberry, spinach, strawberry, Allium sativum, Glycarrhiaza attenuate neuronal cell death induced by oxidative stress."[10,17,19,24,28]

Our work concludes that phytoestrogenous drug *A.racemosus* is a potential antioxidant whose intake can strengthen the levels of SOD, Catalase, Ascorbic acid in Stress+dose group, simultaneously reduce LDH and MDA levels which are clear markers of neuronal death.

References

1. Aksenov M, Aksenova M, Butterfield D, Geddes J, Markesbery W. Protein oxidation in the brain in Alzheimers disease. Neuroscience. 2001;103(2):373–83.
2. Bandyophadhyay U, Das D, Banerjee RK. Reactive oxygen species: Oxidative damage and pathogenesis. Current Science. 1999; 77(5):658-65.
3. Beal MF. Aging, energy, and oxidative stress in neurodegenerative diseases. Annals of Neurology. 1995;38(3):357–66.
4. Bondy SC. The Relation of Oxidative Stress and Hyperexcitation to Neurological Disease. Experimental Biology and Medicine. 1995Jan;208(4):337–45.
5. Buege A, Aust D. The Thiobarbituric acid assay. Methods in Enzymology.1978;52: 306.
6. Chen J, He J, Hamm L, Batuman V, Whelton PK. Serum Antioxidant Vitamins and Blood Pressure in the United States Population. Hypertension. 2002;40(6):810–6.
7. Gilgun-Sherki Y. Antioxidant Therapy in Acute Central Nervous System Injury: Current State. Pharmacological Reviews. 2002Jan;54(2):271–84.
8. Gilman S, Bonner M, Pellmar T. Effect of oxidative stress on excitatory amino acid release by cerebral cortical synaptosomes. Free Radical Biology and Medicine. 1993;15(6):671–5.
9. Hantraye P, Brouillet E, Ferrante R, Palfi S, Dolan R, Matthews RT, et al. Inhibition of neuronal nitric oxide synthase prevents MPTP–induced parkinsonism in baboons. Nature Medicine. 1996;2(9):1017–21.
10. Hong JT, Ryu SR, Kim HJ, Lee JK, Lee SH, Kim DB, et al. Neuroprotective effect of green tea extract in experimental ischemia-reperfusion brain injury. Brain Research Bulletin. 2000;53(6):743–9.
11. Kirkwood B. Mutat Research.1989;219:1.
12. Kuhn A. Oxygen free radicals & antioxidants. Am. J. Nursing. 2003;103(4): 58-62.
13. Law, A. (2001). Say NO to Alzheimer's disease: the putative links between nitric oxide and dementia of the Alzheimer's type. Brain Research Reviews, 35(1), pp.73-96.
14. Masters JN, Finch CE, Sapolsky RM, Nicoll CS. Glucocorticoid Endangerment of Hippocampal Neurons Does not Involve Deoxyribonucleic Acid Cleavage. Endocrinology. 1989;124(6):3083–8.
15. Natelson, S. (1971). Techniques of clinical chemistry. 3rd ed. Charles C. Thomus. U.S.A.
16. Olanow, C. (1992). An introduction to the free radical hypothesis in Parkinson's disease. Annals of Neurology, 32(S1), pp.S2-S9.
17. Pedraza-Chaverrí JCA, Tapia E, Medina-Campos ON, Granados MDLÁ, Franco M. Garlic prevents hypertension induced by chronic inhibition of nitric oxide synthesis. Life

Sciences. 1998;62(6).

18. Peng, J., Jones, G. and Watson, K. (2000). Stress proteins as biomarkers of oxidative stress: effects of antioxidant supplements. Free Radical Biology and Medicine, 28(11), pp.1598-1606.
19. Schroeter H, Williams RJ, Matin R, Iversen L, Rice-Evans CA. Phenolic antioxidants attenuate neuronal cell death following uptake of oxidized low-density lipoprotein. Free Radical Biology and Medicine. 2000;29(12):1222–33.
20. Sies, H. (1985). Oxidative Stress: Introductory remarks In: Oxidative stress. Ed:1-5, Acad Press. London.
21. Sinha AK. Colorimetric assay of catalase. Analytical Biochemistry. 1972;47(2):389–94.
22. SKAPER, S., FLOREANI, M., CECCON, M., FACCI, L. and GIUSTI, P. (1999). Excitotoxicity, Oxidative Stress, and the Neuroprotective Potential of Melatonin. Annals of the New York Academy of Sciences, 890(1 NEUROPROTECTI), pp.107-118.
23. Kumar U, Sharan A, Kamal S. Raised Serum Lactate Dehydrogenase associated with gangrenous small bowel volvulus: A case report. Indian Journal of Clinical Biochemistry. 2003;18(2):6–7.
24. Vaya J, Belinky PA, Aviram M. Antioxidant Constituents from Licorice Roots: Isolation, Structure Elucidation and Antioxidative Capacity Toward LDL Oxidation. Free Radical Biology and Medicine. 1997;23(2):302–13.
25. Weisshaar, D. (1975). Med Welt. 1975;26:387.
26. Wills D. Evaluation of lipid peroxidation in lipids and biological membranes. In: Biochemical Toxicology. Snill K and Mullock B (eds). IRL Press, 1987; 127-157.
27. Winterbourn C, Hawkins E, Brian M, Carrel W. The estimation of red cell superoxide dismutase activity. J. Lab. Clinical. Medicine.1975; 85: 337-341.
28. Youdim KA, Joseph JA. A possible emerging role of phytochemicals in improving age-related neurological dysfunctions: a multiplicity of effects. Free Radical Biology and Medicine. 2001;30(6):583–94.
29. DT. GES. Klin. Chem.(Hrsg.): Standardisierung von Methoden zur Bestimmung von Enzymaktivaten in biologischen flussigkeiten. Klin.Biochem. 1970;8: 658-660.
30. Z. Klin. Chem. Klin. Biochemistry. 1972;10:182.

Modelling and Simulation of AC/DC/AC Converter Based Wind Energy Conversion System

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Abstract

In this paper, PMSG based wind power translation scheme with steady wind speed, variable wind speed and diverse slipup situation are investigated. WPCS is standed on fed by AC-DC-AC translator. Anticipated Regulated provided a variable electricity variable regularity source into a Preset electricity Preset regularity supply. Standard 3-Stage AC-DC-AC translator, translator regulated techniques for wind power generation, wind propellent, 2 mass impel train with PMSG originator are sculpted using MATLAB / SIMULINK for establishing variable-pace wind power translation schemes. Developed wind power translation schemes have been validated in the course of simulation cram using MATLAB / SIMULINK, under diverse input/output status of affairs like invariable wind pace, variable wind pace, and diverse slipup status of affairs. simulation outcomes verify validity of developed wind power translation scheme and its regulated.

Keywords: AC-DC-AC translator, PMSG, 2 mass impel train, wind propellent, wind power

Introduction

In view of comprehensive tepiding that emanation of carbon has drawn full mapped path the need to develop uncontaminated and continuable power sources like the wind energy and hydro power is identified. Wind power has had a tremendous growth during past ten years. It is just because wind power is a pollution-free resource and an unlimited potential. Capacity of wind propellent installations has also grown from three hundred KW in the initial stages, and extended up to 10 Mega Watt capacity. Primary negative aspect of wind is that it is irregular in occurrence. Problem turns into how to maximize power capture from wind. Wind power can be harnessed by a wind power translation scheme, composed of a wind propellent, an electric originator, a power electronic translator and corresponding regulated scheme. Based on types of components used, diverse WPCS structures can be realized. The objective in all structures is the same, i.e., wind power at varying wind velocities has to be converted to electric grid regularity. In terms of originators for wind power application, there are two main classes considering pace: invariable and variable pace. Invariable pace wind propellents and induction

originators were often used in early stages of wind power development. Some of the disadvantages of fixed pace originators are short efficiency, poor power quality, high mechanical stress and the fact that by having a fixed pace operation coefficient of performance is obtained only at a particular wind pace. Due to development of power electronics and its falling costs, variable pace operation has come to be the most attractive option. By running wind propellent originator in variable pace and variable regularity mode maximum power can be extracted, at short and medium wind paces. Among all kinds of wind power translation schemes, a variable pace wind propellent equipped with a multi pole Stable magnet contemporaneous originator is found to be very attractive application in large wind farms. With gearless construction, such concept requires short maintenance, abridged losses and costs, high efficiency and good regulated ability. At present PMSG based WPCS has been commercialized by some WT manufactures.

A. Conventional constant pace wind power scheme

Figure 1 presented below shows the conventional Preset pace type wind propellent direct allied or with gear allied to the grid:

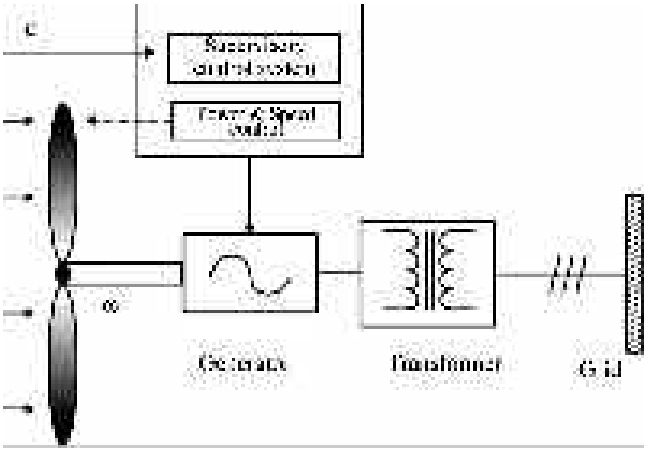


Figure 1: Preset pace type wind power translation scheme

B. Variable pace wind generating scheme

A variable pace wind generating scheme allied to grid is made known in Figure 2.

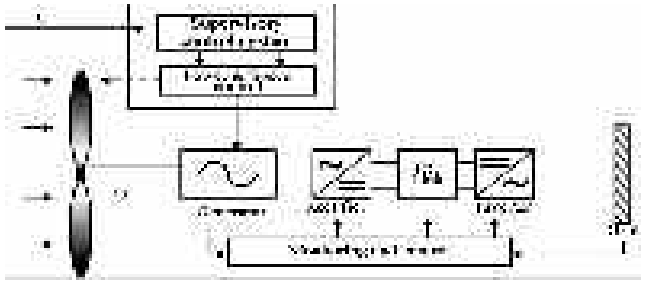


Figure 2: Variable pace type wind power translation scheme

C. Wind Propellent Arrangement

Originator is allied in the course of a full scale electricity source translator: originator translator is applied to regulate the torque and pace and grid side translator is used to regulated power short in order to keep DIRECT CURRENT-link electricity invariable. Two translators are allied by a DIRECT CURRENT link capacitor in order to have a disconnected regulated for each translator.

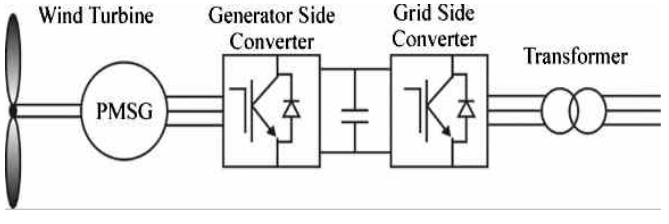


Figure 3: Wind propellent arrangement

Sculpting of Wind Power Translation Scheme

Blueprint & sculpting of components of WPCS Scheme like sculpts of contemporaneous originator, AC-DC-AC PWM translator, wind propellent, impel train & ir-regulated scheme are discussed in detail.

A. Anticipated Wind Power Translation Scheme

Anticipated WPCS scheme presented in the Figure below consists of wind propellent, 2 mass impel train, Stable magnet contemporaneous machine.

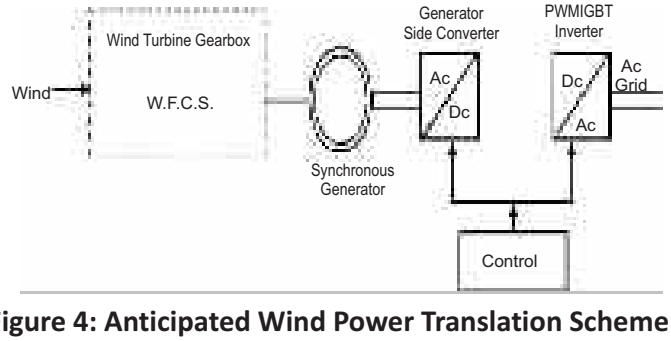


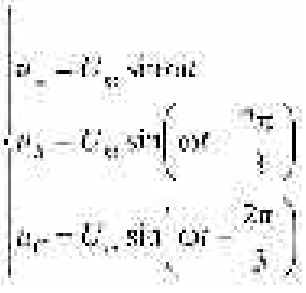
Figure 4: Anticipated Wind Power Translation Scheme

B. Permanent Magnet Synchronous Generator (PMSG)

PMSG is a Contemporaneous Machine, in the course of which Direct Current excitation circuit is reinstated by Stable magnets, by eradicating brushes.

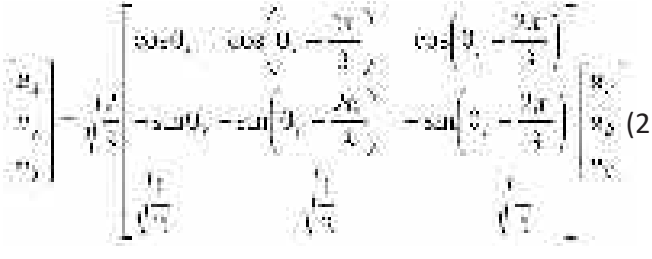
C. 3 Stage PMSG d-q Sculpt

Electricity of a 3-Stage PMSG in Stage coordinate frame which can be expressed in the way presented below:



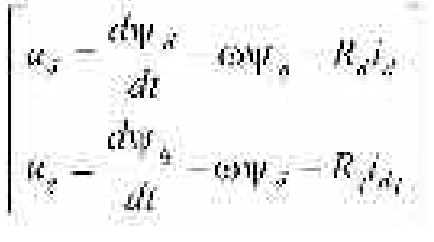
(1)

Um presents the amount of Stage electricity, w presents gaunt regularity of electricity in Stage coordinate frame. Equation 1 can be transformed to d-q axis in the course of below presented conversion format:



(2)

?$_r$ presents rotor point, ?$_r$ presents ?$_0$ + fωdt, ?$_0$ presents initial pint of rotor. After conversion, PMSG electricity is portrayed by :



(3)

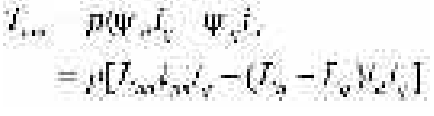
Rd is D - Axis Resistance and Rq present q-axis resistance. Rd presents Rq presents R1, where R1 resistance of PMSG. ψd and ψq present fluxes for the d and q axis subsequently, and id and iq present currents. PMSG flux is portrayed by:

(4)

where Lad is the d-axis armature reaction inductance and L1 is the leakage inductance L_d and L_q present contemporaneous inductance,

(5)

where Laq presents armature reaction inductance of q-axis and ifm presents equivalent current of magnet. So the equation presented below shows electromagnetic torque:

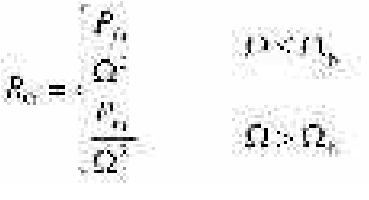


(6)

where p presents pole-pairs. Equational view of mechanics of PMSG is presented below:

(7)

where J represents rotational instant of inertia, Ω represents mechanical angular pace, T_{mec} and T_{em} represents propellent mechanical impel torque & PMSG electromagnetic torque, and $R_Ω$ is damping coefficient which is calcucled from the following presented below:



(8)

where $Ω_N$ represents PMSG angular mechanical pace and P_{fw} presents mechanical loss under rated load status of affairs.

D. AC-DC-AC PWM Translators

A three Stage translator has 6 semiconductors (IGBTs) displayed in three legs: a, b and c. In the figure presented below, Sa, Sb, Sc represent switching status for each leg. Scan only has two values: 1 value for conduction status and 0 value for obstruct status.

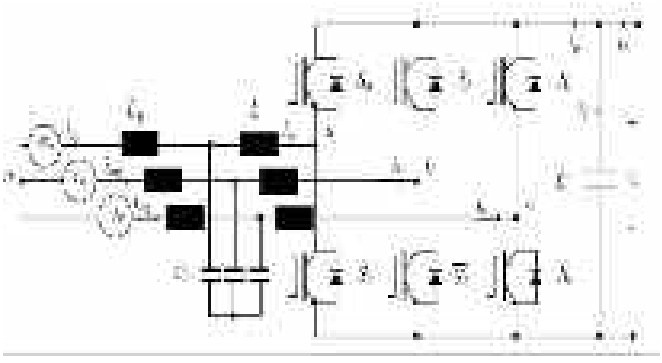


Figure 5 :VSC among ideal switches

Stage electricity is calculated with DIRECT CURRENT electricity and duty cycles D_a, D_b, D_c

$$\begin{cases} v_{ab} = \frac{U_{dc}}{3}(2D_a - D_b - D_c) \\ v_{bc} = \frac{U_{dc}}{3}(D_a + 2D_b - D_c) \\ v_{ca} = \frac{U_{dc}}{3}(-D_a - D_b + 2D_c) \end{cases} \quad (9)$$

DIRECT CURRENT link current can be expressed as:

$$i_{dc} = [D_a D_b D_c] \cdot \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} \quad (10)$$

where i_a, i_b, i_c for above equation present line currents.

E. Wind Propellent and Pitch Regulated

Propellent of WPCS enables translation of kinetic power of wind Ew into mechanical power Pm and eventually into electricity

$$\begin{cases} P_m = \frac{\partial E_w}{\partial t} C_p = \frac{1}{2}\rho A V_w^3 C_p \\ C_p(\lambda,\beta) = 0.5176\left(\frac{116}{\lambda_i} - 0.4\beta - 5\right)e^{-21\frac{1}{\lambda_i}} + 0.0068\lambda \end{cases} \quad (11)$$

where V_w presents wind pace, ρ presents air density,

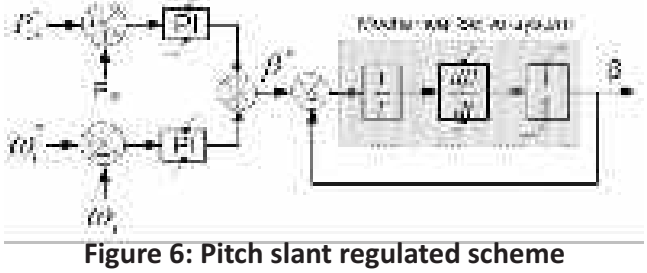


Figure 6: Pitch slant regulated scheme using PI Regulated

Cp presents performance coefficient. Numerical approximation of Cp used in this cram is taken from and λ_i presents f(λ?β) as given by:

$$\begin{cases} \lambda_i = \frac{\omega_t R}{v_w} \\ \frac{1}{\lambda_i} = \frac{1}{\lambda - 0.08\beta} - \frac{0.035}{\beta^3 + 1} \end{cases} \quad (12)$$

where ω?presents propellent pace and R presents blade radius of wind propellent.

F. Sculptling of 2 Mass Impel Train

Using power principles on rotor proposed by the Newtons' Second Law, mathematical sculpt would be as below:

$$Jrw_t + B_r w_t \le T_a - T_{is} \quad (13)$$

Where for the proposed rotor Jr ≤ Instant of inertia (cancelled), wt ≤ Slant pace, Br ≤ Damping effect, Ta ≤ Applied torque, Tls ≤ Short pace shaft torque.

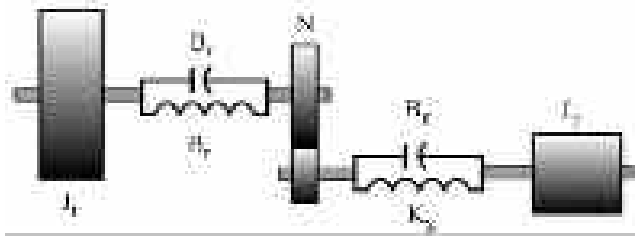


Figure 7: 2 mass impel train sculpt

If the same methodology is induced to driving gear, and if the moment of inertia fundamentally is cancelled, then the output equation would be:

$$J_{iswis} + B_{is}(_{wt}\text{-}_{wis}) + K_{is}(_{t}\text{-}_{is}) = T_{is} \quad (14)$$

Where J1s presents impel moment of inertia, w1s presents angular pace of short pace shaft, B1spresents short pace damping effect, K1spresents stiffness of short pace shaft, qt presents rotor angular displacement, q1spresents short pace angular displacement.

This will yield:

$$T_{is} = B_{is}(_{wt}\text{-}_{wis}) + K_{is}(_{t}\text{-}_{is}) \quad (15)$$

Mathematical sculpt for originator is:

$$J_{gwg} + B_{gwg} = T_{hs} - T_{em} \quad (16)$$

Where J1s presents originator moment of inertia, w_g presents angular pace of elevated pace shaft, B_g presents high pace damping effect, T_{sh} presents high pace shaft torque, T_{gen} presents originator electromagnetic torque, gear train ratio ng is portrayed by :

$$ng = \frac{T_{is}}{T_{hs}} = \frac{W_g}{W_{ls}} = \frac{g}{is} \quad (17)$$

where, w_g presents angular disarticulating of elevated pace shaft.

Implementation of WPCS in MATLAB / SIMULINK

Different apparatuses of wind power translation scheme (WPCS) like contemporaneous originator, AC-DC-AC PWM translator, wind propellent, impel train and its regulated scheme is implemented in MATLAB/SIMULINK settings.

A. Anticipated AC-DC-AC PWM Translator standed WPCS Sculpt

In order to cram effects of entire WPCS, anticipated scheme is sculpted with the help of MATLAB/SIMULINK by means of diverse tool boxes. It incorporates a wind propellent and impel train sculpt, PMSG sculpt, and AC-DC-AC PWM translator and its regulated sculpt. Diverse obstruct sets of SIMPOWER SCHEME is particularly used to blueprint electrical sculpt. Anticipated WPCS presented in Figure 8 is developed through MATLAB/SIMULINK.

Figure 8: Anticipated Wind Power Translation Scheme in MATLAB/SIMULINK

B. Wind Propellent Sculpt

The wind propellent sculpt blueprinted in MATLAB/SIMULINK is made known in Figure 9. An assortment of aspects of wind propellent blueprint is presented below:

"Ostensible mechanical yield power (W): 8.5e3, Base power of electrical originator (VA): 8.5e3/0.9, Base wind pace (m/s): 8, Maximum power at base wind pace (p.u. of nominal mechanical power): 0.8 and Base rotational pace (p.u. of base originator pace): 1."

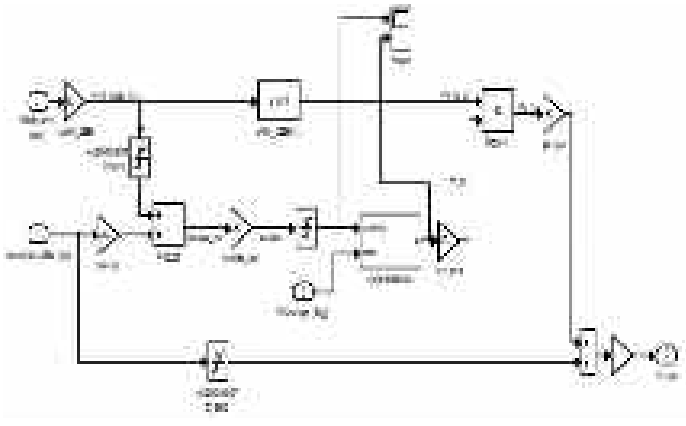


Figure 9 : Wind Propellent Sculpt

C. 2 Mass Impel Train Sculpt

2 mass impel train sculpt is made known in Figure 10. The above sub-scheme will give shaft torque T_ shaft(pu), W_wtas outputs and T_wt(pu), originator pace(pu) as input. In this closed loop regulated scheme feedback is granted just before gain as presented.

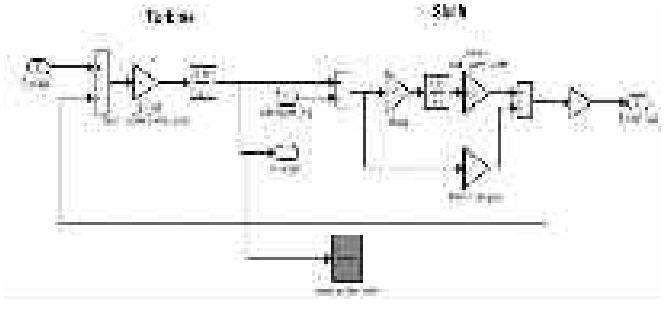


Figure 10: Two Mass Impel Train Sculpt

D. Pitch Slant Regulated

Pitch slant Regulated blueprinted is made known in Figure11. Where pitch compensator is also blueprinted with Proportional gain (Kp):1.5, Integral gain (Ki):6, output max. Limit: 45, min. limit: 0, Pitch Gain: 500.

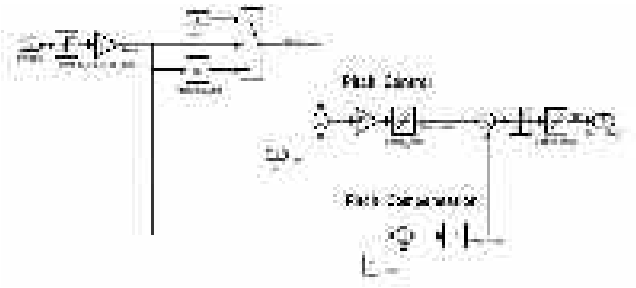


Figure 11: Pitch Slant Regulated

E. AC-DC-AC PWM Translators

PWM Regulated blueprinted to produce gate pulse is shown in Figure 12. Electricity Regulated blueprint presented in Figure 13 with Proportional gain (Kp): 0.4, Integral gain (Ki): 500, Carrier regularity (Hz):2000. abc_to_dqo Conversion, Discrete virtual PLL, Discrete PID Regulated, dqo_to_abc Conversion, Discrete PWM originator developed in MATLAB/SIMULINK is presented in Figure 12 to Figure 15 with proportional gain (Kp) and integral gain (Ki). Proportional gain (Kp) apply to 0 order hold 0-Order hold obstruct samples and holds its contribution to the specific step.

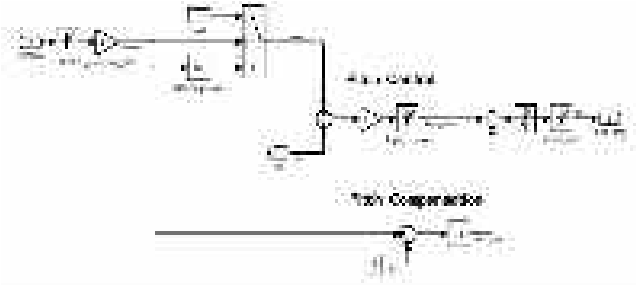


Figure 12: PWM controller

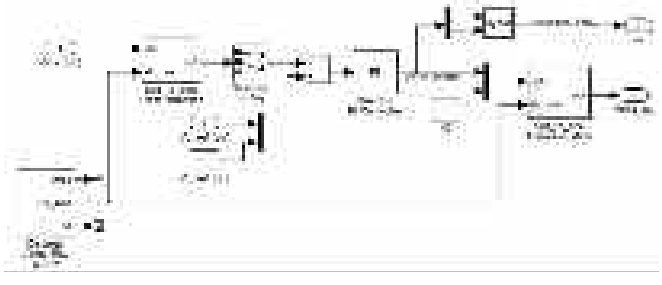


Figure 13: Electricity Regulated

Ki is pertains to Discrete-Time Integrator (DTI) obstruct in place of Integrator obstruct to create a purely discrete scheme. Both 0 order hold and DTI obstruct apply sum and saturation obstruct and got output. It is a closed loop regulated scheme that produces and outputs a signal in relation to regularity and Stage of an contribution signal as input.

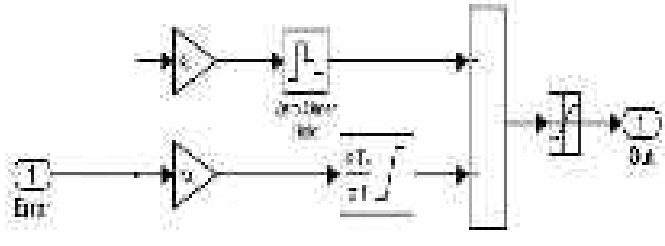


Figure 14 : Discrete PID Regulated

It will generate 3 outputs Freq, wt and sin_cos out. Sin and Cos are clubbed into a single pool.

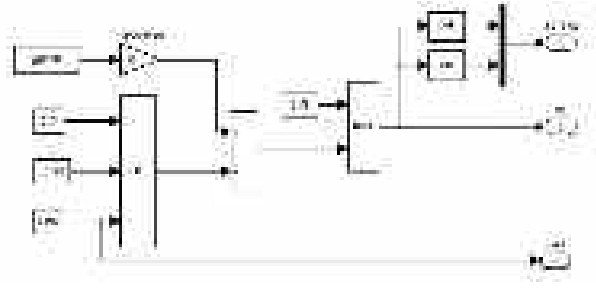


Figure 15: Disconnected Virtual PLL

Discussion

In this research, simulation outcomes of developed wind power translation scheme allied to a utility grid under diverse status of affairs i.e. under invariable wind pace, step alteration in wind pace, three Stage to position slipup etc. were depicted to authenticate developed sculpts and regulateds for anticipated wind generation scheme.

Situation - 1 Under Invariable Wind Pace

WPCS schemes have been tested for invariable wind pace of 12 m/s as made known in Figure16 to Figure 21.

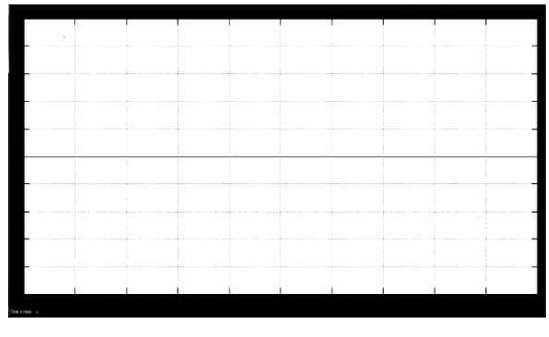


Figure 16 : Invariable Input Wind Pace

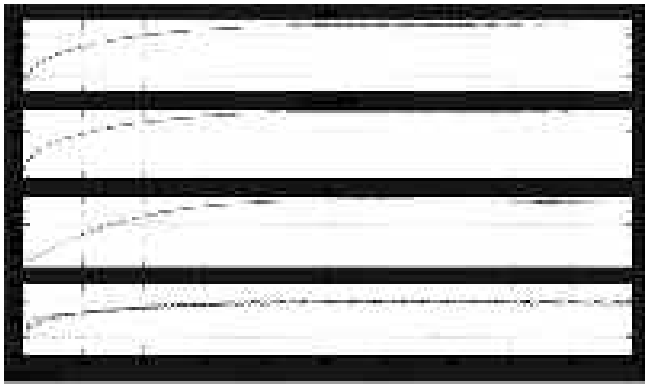


Figure 17: Waveshape of Contemporaneous originator Rotor wind pace Wm (rad/sec), Mechanical Torque (Tm), Electromagnetic Torque (Te)

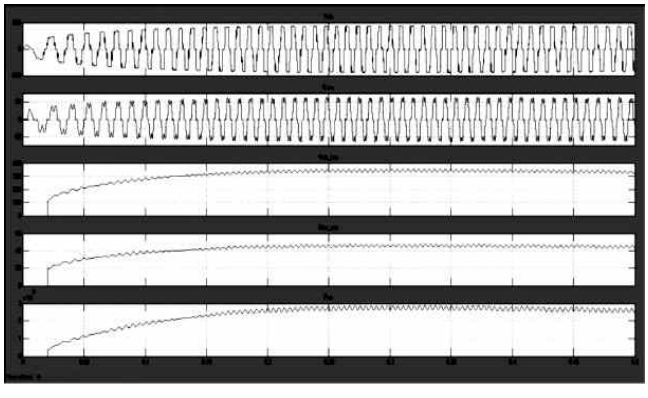


Figure 18: Waveshape of line to line Electricity (Vab), Line Current (IL), rms Line Electricity (Vab_rms), AC Power

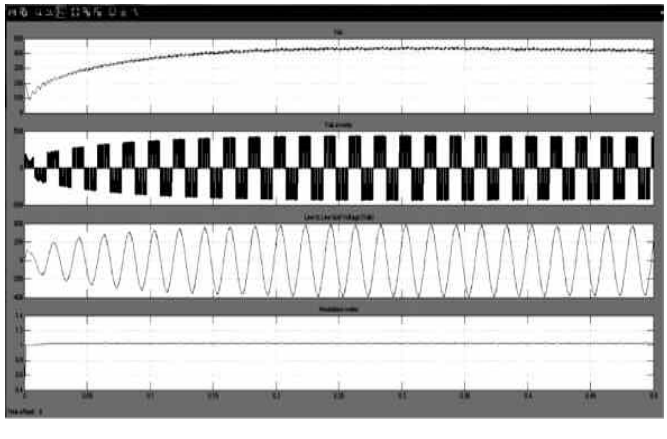


Figure 19: Waveshape of dc link electricity, Inverter yield AC electricity, line to line grid electricity, and modulation Index

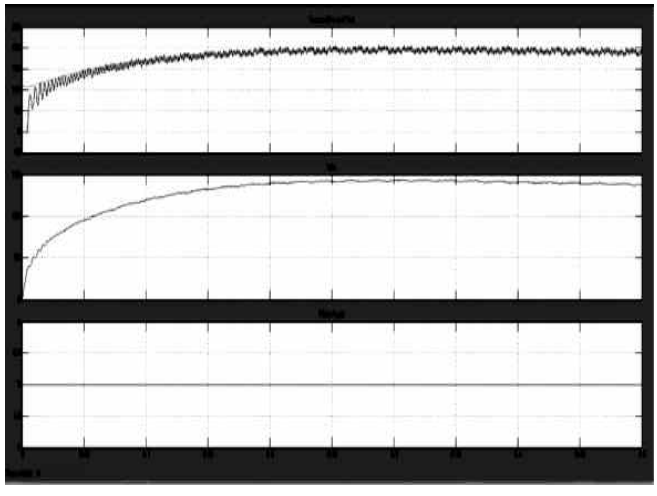


Figure 20: Torque (Tm and Te), Rotor pace and pitch slant

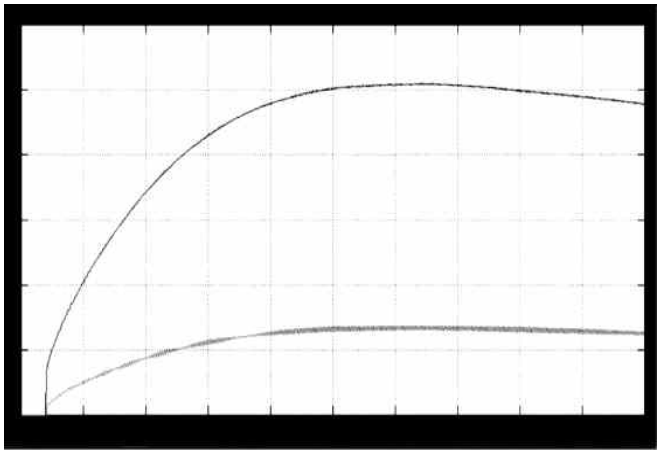


Figure 21: Instantaneous Active and reactive power Waveshapes

Situation-2 Under Step Alteration in Wind Pace

WPCS scheme has been tested under step alteration in wind pace. A alteration made in wind pace at time tpresents5 sec. from 8m/s to 18 m/s. Different Waveshapes like originator Rotor wind pace Wm (rad/sec), mechanical torque (Tm), electromagnetic torque (Te), line to line Electricity (Vab), Line Current (IL) rms Line Electricity (Vab_rms), AC Power, Rotor slant (rad), Stator Current Is_A, Is_B, Is_C,and direct and quadrature axis Stator electricity are made known. It can be seen from Waveshapes that at time t presents 5 sec.

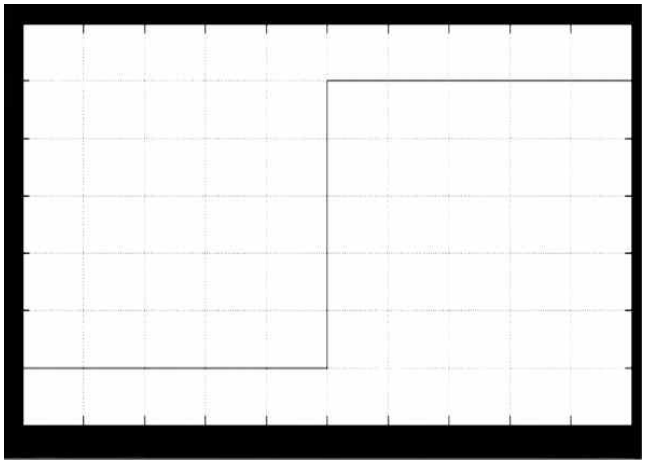


Figure 22: Alteration in Input Wind Pace

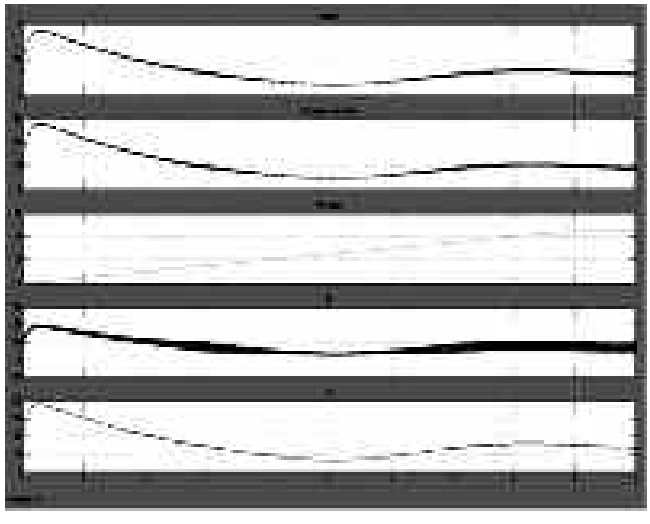


Figure 23: Waveshape of Contemporaneous originator Rotor wind pace Wm (rad/sec), Mechanical Torque (Tm)

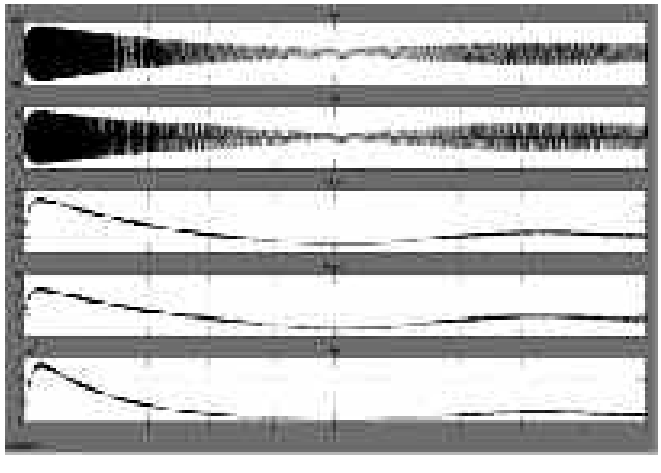


Figure 24: Waveshape of line to line Electricity (Vab), Line Current (IL), rms Line Electricity (Vab_rms), AC Power

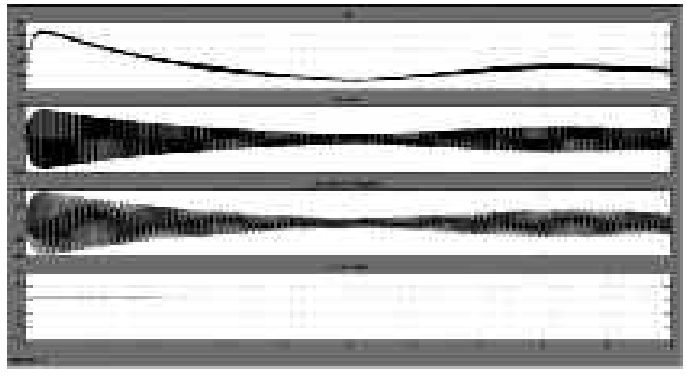


Figure 25: Waveform of dc link voltage, Inverter output AC voltage, line to line grid voltage, and modulation Index

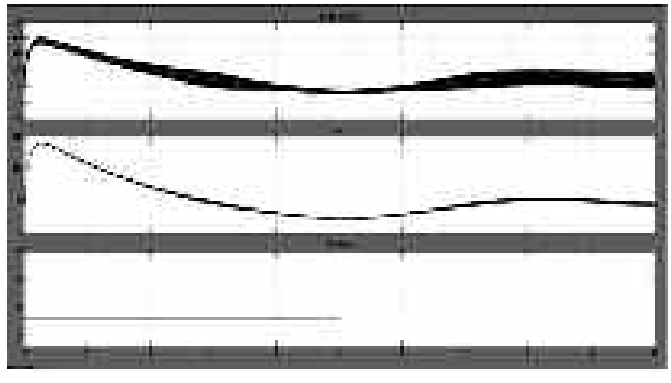


Figure 26: Torque (Tm and Te), Rotor pace and pitch slant

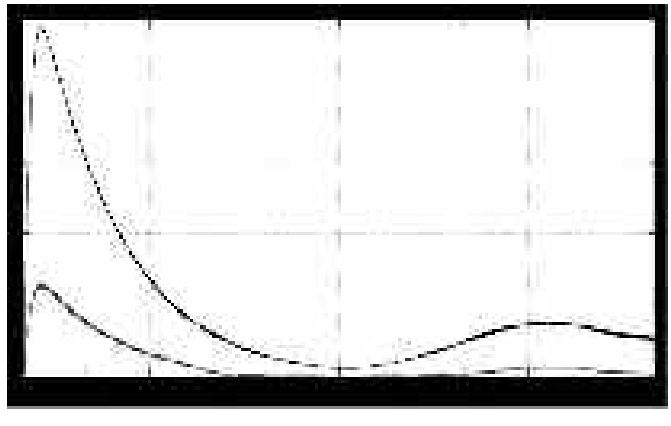


Figure 27: Instantaneous Active and reactive power Waveshapes

Situation-3 Under Slipup Status of Affairs at Grid Side

A. 3 Stage to Position Slipup

To examine the trust and relaibility of developed WPCS scheme, 3 Stage to position slipup has been

applied at time tpresents0.4 sec. for a duration of 0.1 sec. After which, slipup has been cleared. Simulation outcomes are presented in the figures below from 28 to 31. It can be observed from the figures that during slipup period, electricity turns into almost 0, dc electricity turn into 0, grid electricity and current also turns into 0.

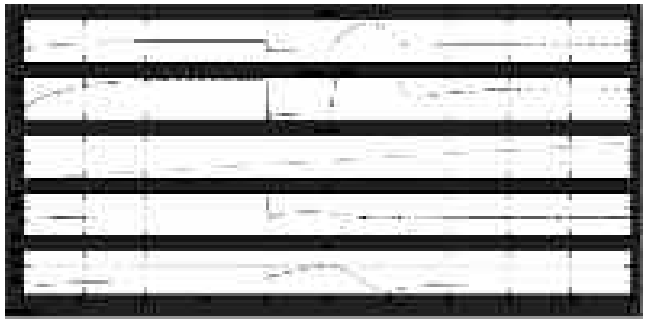


Figure 28: Waveshape of Contemporaneous originator Rotor wind pace Wm (rad/sec), Pitch Slant, Mechanical Torque (Tm), Electromagnetic Torque (Te)

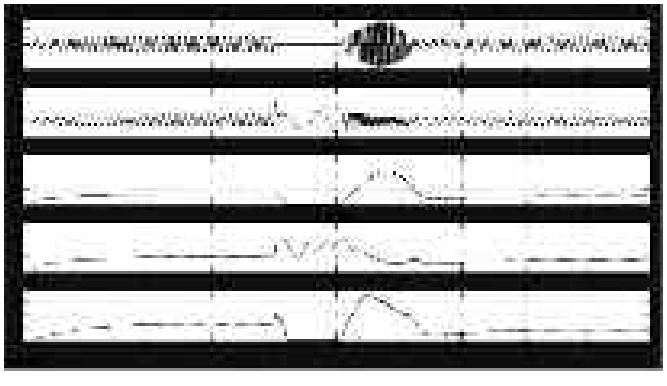


Figure 29: Waveshape of line to line Electricity (Vab), Line Current (IL), rms Line Electricity (Vab_rms), AC Power

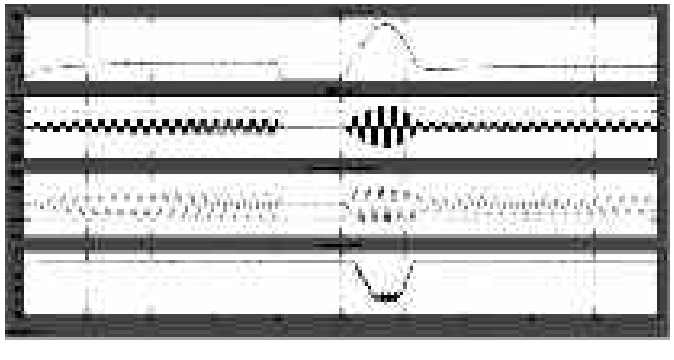


Figure 30: Waveshape of dc link electricity, Inverter yield AC electricity, line to line grid electricity, and modulation Index

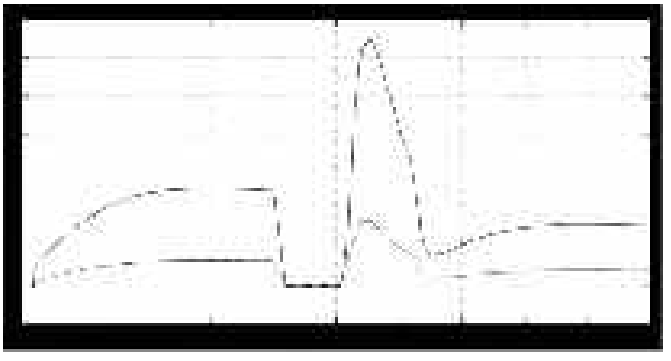


Figure 31: Instantaneous Active and reactive power Waveshapes

B. 2 Stage to Position Slipup

To test validity of developed WPCS scheme, 2 Stage to position slipup has been applied at time tpresents0.4 sec. for a duration of 0.1 sec. after which, slipup has been cleared. Simulation outcomes from Figure 32 to Figure 35 showed response of different factors of developed sculpt during slipup condition. After slipup period, aspects go through transients and conquer stable status within very short time.

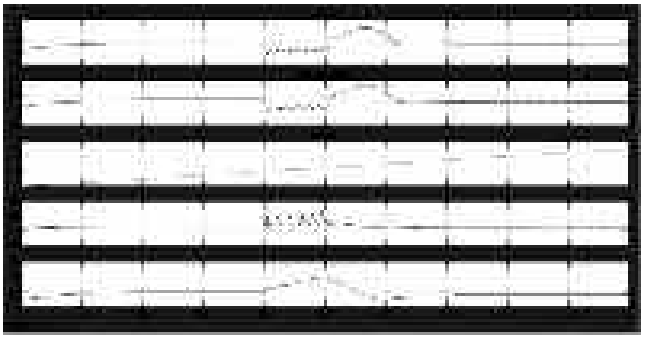


Figure 32: Waveshape of Contemporaneous originator Rotor wind pace Wm (rad/sec), Pitch Slant, Mechanical Torque (Tm), Electromagnetic Torque (Te)

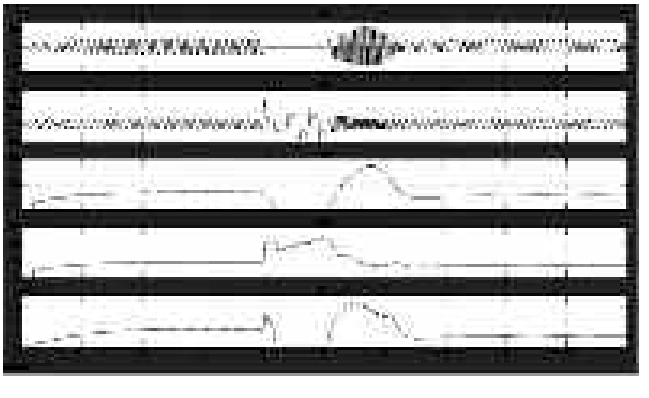


Figure 33: Waveshape of line to line Electricity (Vab), Line Current (IL), rms Line Electricity (Vab_rms), AC Power

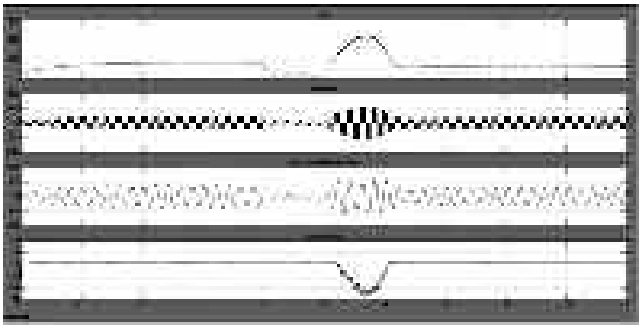


Figure 34: Waveshape of dc link electricity, Inverter yield AC electricity, line to line grid electricity, and modulation Index

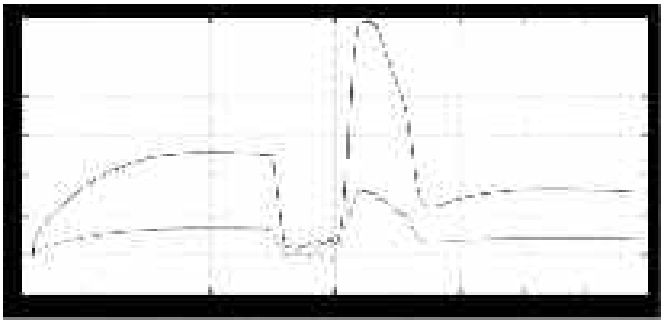


Figure 35: Instantaneous Active and reactive power Waveshapes

C. Single Stage to Position Slipup

To authorize the proposed WPCS scheme, single Stage to position slipup has been applied at time t presents 0.4 sec. For the particular time interval of 0.1 sec., slipup has been unfurnished. Recreation outcomes from Figure 36 to Figure 40 show response of different aspects of developed sculpt for the duration of slipup condition. It was observed that for the duration of slipup period, electricity turns into almost 0, current undergoes transients, and dc electricity turns into 0, grid electricity and current also turns into 0.

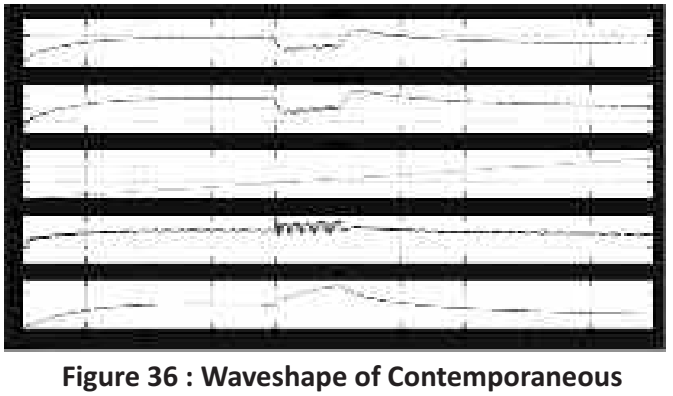


Figure 36 : Waveshape of Contemporaneous originator Rotor wind pace, Slant, Mechanical Torque (Tm), Torque

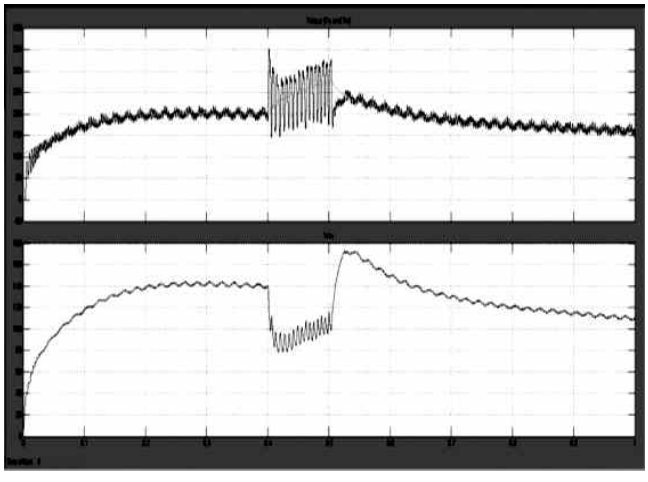


Figure 37: Tm and Te, Rotor pace

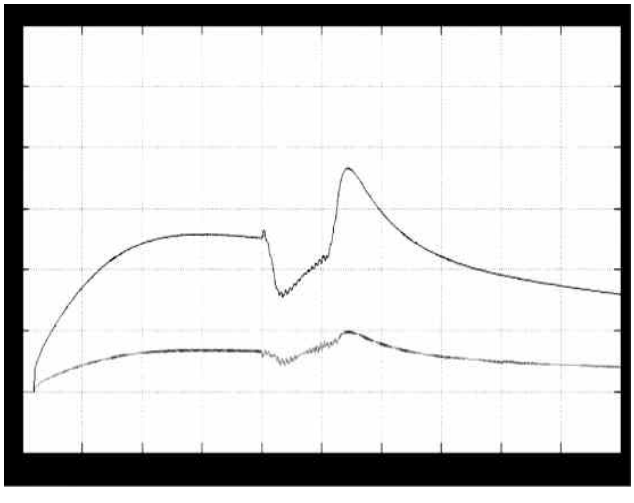


Figure 38: Immediate Active and reactive power Waveshapes

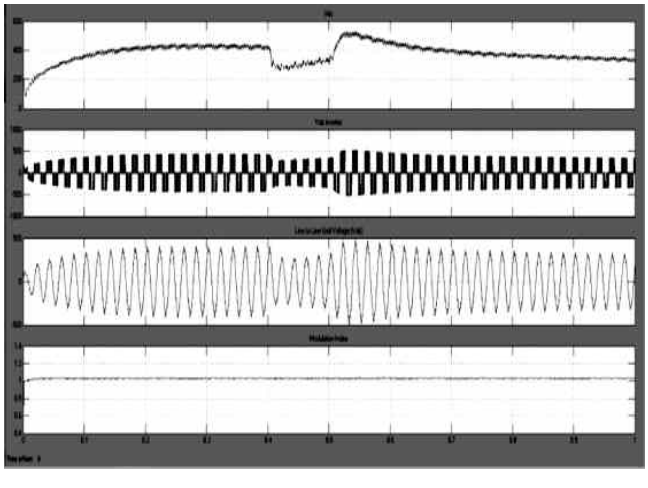


Figure 39: Waveshapes dc- link electricity, Inverter yield AC electricity, line to line grid electricity, and modulation Index

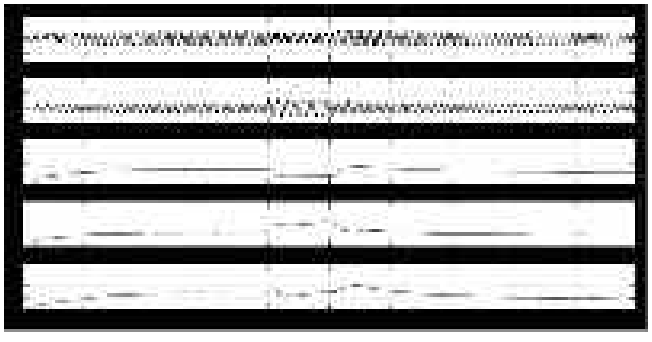


Figure 40: Waveshape of Vab, IL, Vab_rms and AC Power

Conclusion

De-coupling between originator-side and grid-side translator is granted by DC- link capacitor, a reby presents disconnected regulated flexibilities for power translators. developed sculpt and its regulated was replicated by MATLAB/SIMULINK and tested/validated for diverse status of affairs i.e. invariable and variable wind pace, diverse slipups like 3 Stage to position etc. outcomes depicted in the figures presented good presentations and outcomes of developed sculpt and regulated. Subsequent to slipup has cleared, different aspects regain in the steady status values for the squat time period, indicating fort of regulated action.

References

1. Zhang, S., Tseng, K., Vilathgamuwa, D., Nguyen, T. and Wang, X. (2011). Design of a Robust Grid Interface System for PMSG-Based Wind Turbine Generators. IEEE Transactions on Industrial Electronics, 58(1), pp.316-328.
2. Kumar V, Joshi R, Bansal R. Optimal Control of Matrix-Converter-Based WECS for Performance Enhancement and Efficiency Optimization. IEEE Transactions on Energy Conversion. 2009;24(1):264–73.
3. Bhende, C., Mishra, S. and Malla, S. (2011). Permanent Magnet Synchronous Generator-Based Standalone Wind Energy Supply System. IEEE Transactions on Sustainable Energy, 2(4), pp.361-373.
4. Xia, Y., Ahmed, K. and Williams, B. (2011). A New Maximum Power Point Tracking Technique for Permanent Magnet Synchronous Generator Based Wind Energy Conversion System. IEEE Transactions on Power Electronics, 26(12), pp.3609-3620.
5. Koutroulis, E., Kalaitzakis, K. (2006). Blueprint of a maximum power tracking scheme for wind-power-translation applications. IEEE Transactions on Industrial Electronics, 53(2), pp.486-494.
6. Okedu KE, Muyeen SM, Takahashi R, Tamura J. Wind Farms Fault Ride Through Using DFIG With New Protection Scheme. IEEE Transactions on Sustainable Energy. 2012;3(2):242–54.
7. Wang, H., Nayar, C., Su, J. and Ding, M. (2011). Control and Interfacing of a Grid-Connected Small-Scale Wind Turbine Generator. IEEE Transactions on Energy Conversion, 26(2), pp.428-434.
8. Amin, M. and Mohammed, O. (2011). Development of High-Performance Grid-Connected Wind Energy Conversion System for Optimum Utilization of Variable Speed Wind Turbines. IEEE Transactions on Sustainable Energy, 2(3), pp.235-245.
9. Sasi, C. and Mohan, G. (2013). Performance analysis of grid allied wind power translation scheme with a PMSG during slipup status of affairs. International Journal of Engineering and Advanced Technology. 2(4), pp.356-361.

Optimised Transformation and Loading Algorithm in ETL Process for the Development of Large Scale Warehouse

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Abstract

Websites are a huge and unique source of information, out of such huge information available on the websites, finding and analysing the required and relevant data is critical as the data may be foul, which consist duplicate data, misspelled or wrongly spelled data. Determining integrated record that stand for identical real world entities in abundant ways is the major problem to solve in database. Hence, data transformation is required to determine pertinent information which is easy to examine. Since the data on the web is “very large”, loading the clean data in data warehouse is required for fast processing on data to achieve accurate result. In this paper one of the techniques used for data cleaning is to remove duplicate records from the patent database by employing token wise sentence sorting and then levenshtein distance for string matching is applying. The cleaned data is transformed data that is loaded from staging area to hadoop environment.

Keywords: Duplicate data, Data transformation, Data loading, Levenshtein distance matching, Hadoop

Introduction

Web documents are an enormous source of knowledge and information. These contain information which is used by public, private and government sectors to observe the progress going on in their respective domains. Data which is acquired and processed for mining is identified and cleaned before loading it to the warehouse. Massive amount of data generated every minute of the day and hence there is copious data present in the world. Data in the databases of the firms and social media is enormous i.e Petabyte and zetabyte and obtaining useful data is the real task, as without accurate data one can't get exact result. Here, the need of data transformation arises. Many independent sources of data are merged into a gigantic vault known as data warehouse for querying and analysis purpose. [1]

The data present in the staging area can be heterogeneous. "There are possibilities that data may not be clean data" [2,3] i.e. errors such as spelling mistakes, typographical errors or name variants might be present. "Also database share different schema to store information or sometimes multiple datasets are merged which creates more difficulty to deal with the data."[4] "The aim is to remove such duplicacy from the database." [5,6] Duplicacy removal process works in two ways, initially it identifies the exactness, whether two records are exact copies of each other, if so it detect the duplicate records and then removes one copy out of two to make the data unique and accurate. The existing techniques for duplicacy removal from database performs the sorting of the database and removes the records in the neighbourhood which are similar, based on exact match or single match error removal algorithms, the technique applied in this paper pre-process the database before sorting the database so that similar records come up together. To deal with such a problem first token wise sorting is done for the pre-processing of the dataset followed by levenshtein distance matching.

"To load the data in the data warehouse data pre-processing is required to discover the knowledge."[7] "There are several companies or organizations that spend a lot of money on identification and removal of errors."[9] Handling the correctness of data manually is time consuming and arduous, still there remain chances for errors. Therefore the need of automation in the cleaning process is required. "For this purpose research is made to achieve the quality data in the data warehouse."[10] Unless the exact and accurate information about duplicate data is not known, processing of the data for further analysis cannot be done as it may produce untrustworthy data. The present work is divided into two parts: first, data transformation and second, loading of the data in data warehouse. "Data cleaning is the technique for data transformation to scrub the data and deal with missing, incorrect data, remove replicated data"[11] and store it to warehouse so that it can be used for better analysis. Data cleaning is required in several fields such as telecommunication, banking, transportation, retailing, IP analyses social media sites etc. Data cleaning is a vast term and its definition depends upon the area it is applied, the major domain on which data cleaning is applied or studied are data warehouse, data knowledge discovery and data quality management. "The aim of data cleaning is to achieve the efficient data quality."[12] Data cleaning is performed on the data before moving it to data warehouse so that further data mining techniques and queries can be applied on the data set to achieve better and efficient results. Loading is the step in which cleaned data is transferred into target source. Rest of the paper is organised as follows. Section II explains related work. Section III describes the proposed work, section IV covers the experiments and results and finally section V concludes the paper.

Related Work

There has been some work done previously on duplicacy removal or de-duplication of the records in the database table. The problem of representation of same objects in different forms is known as "field matching problem."[7] Buckles and Petry[13] study the fuzzy relational database to make out alike occurrences of the existence of objects through inexact match. Fuzzy relational database focuses on the relevant and efficient results by firing a fuzzy query on the fuzzy relational database, but this paper is more concerned with the pre-processing of the data even before it is ready for the query. There is also work done on field matching but that is only on the specific area, T.F. Smith and M.S. Waterman[14] proposed algorithm for identification of common molecular subsequence for matching DNA and protein sequence. C.Jacqemin and J.Royaute[15] proposed technique to retrieve terms and their variants in a lexicalized unification-based framework. A.E.Monge and C.P.Elkan[8] give the algorithm for approximate duplication of the records and properties that must have by pair-wise records for the successful removal of the duplicates. The easy and best way to remove duplicates from the database is to sort the database and identify the duplicate records adjacent to each other; this technique of cleaning the database by removing duplicates is given by D.Bitton and D.J.Dewitt.[16]

Proposed Work

A. Transformation

Data transformation is the process to convert the data from one format to another according to the need. Transformation in data mining is performed before storing the data in the data warehouse after that data mining techniques can be performed on the data to get trustworthy result in less time. Here the steps for data cleaning are proposed to remove duplicacy in the records so that it can be stored in data warehouse for further use and easy access.

Transformation algorithm

1. Establish the database connectivity
2. Tokenize the elements within the field
3. Perform token wise sorting within the field
4. Choose a key to sort database
5. Sort the database based on the chosen key
6. Execute the levenshtein matching
7. Remove the records which are not unique

1. Token wise Field Sorting

The main issue of our database is a different representation of the same real world entity which creates the duplicacy. To deal with this problem first tokenize the components within the field. Tokenization can be done by using delimiter such as colons, semi- colons, space, punctuations etc. Sample data is taken from patent portal for e.g. tokens in the patent inventors field {Aoki; Shigenori (Kawasaki, JP), Kato; Masayuki (Kawasaki, JP)}. After sorting the tokens result is {Aoki; Masayuki (Kawasaki, JP); Shigenori (Kawasaki, JP)

TABLE I: Dataset from Patent Database

PATENT INVENTORS
Sofet; Marco(Rivarolo Canavese,IT)
Takamastsu; Shuji(Kanagawa,jp)
De Dobbelaere; Peter(San Diego,CA)
Kawamoto; Hirnori(Kawaguchi,jp)
Marco(Rivarolo Canavese,IT); Sofet

TABLE II: Token Wise Field Sorting

PATENT INVENTORS
Marco(Rivarolo Canavese,IT); Sofet
Shuji(Kanagawa,jp); Takamastsu
De Dobbelaere; Peter(San Diego,CA)
Hirnori(Kawaguchi,jp); Kawamoto
Marco(Rivarolo Canavese,IT); Sofet

2. Database sorting

Database sorting is performed after token wise sorting. Database sorting depends on the key chosen for the sorting. Choosing the key also plays a vital role in bringing records near and helping in the identification in the duplicacy of records. So choosing the key to sort database should be a wise decision.

TABLE III: Database after applying Database Sorting

PATENT INVENTORS
De Dobbelaere; Peter(San Diego,CA)
Hirnori(Kawaguchi,jp); Kawamoto
Marco(Rivarolo Canavese,IT); Sofet
Marco(Rivarolo Canavese,IT); Sofet
Shuji(Kanagawa,jp); Takamastsu

3. Matching Records

Token wise sorting followed by the database sorting, records are bought together or nearby so that finding out duplicate records out of them will be easy. For matching the records, there are several string matching algorithms proposed such as exact string matching, single error string matching, levenshtein string matching etc.

i. Exact string matching

Exact string matching will return the value 1 if the strings are exact match of one another else 0.

ii. Single Error String Matching

Single error string matching checks for the single error between two strings. It compares two strings if there is some missing character, additional character or substitution of character. It allows only one error out of these three.

iii. Levenshtein Distance Matching

Levenshtein distance matching checks the changes required to make two strings same by performing the simple operations such as delete, insert or update. Mathematical equation for levensthein distance matching works is –

$$Lev_{a,b}(i,j) \leq \begin{cases} \max(i,j) & \text{if } m \text{ in}(i,j) \leq 0, \\ \min \begin{cases} lev_{a,b}(i-1, j) + 1 \\ lev_{a,b}(i,j-1) + 1 \\ lev_{a,b}(i-1,j-1) + 1 \end{cases} & (a_i \leq ! \, b_j) \end{cases}$$

Where, i≤ first i characters in string a

j≤ first j characters in string b

a,b ≤ strings for comparison

TABLE IV: Dataset without Duplicacy

PATENT INVENTORS
De Dobbelaere; Peter(San Diego,CA)
Hirnori(Kawaguchi,jp); Kawamoto
Marco(Rivarolo Canavese,IT); Sofet
Shuji(Kanagawa,jp); Takamastsu

B. Loading

Loading is the process to transfer the data from source to destination. In the loading phase, data from staging area is transferred to the data warehouse. There are periodic updates in data warehouse rather than continuous. Large number of records are loaded to multiple tables in single data load. Loading process should be designed in such a way that offline time of data warehouse can be minimized. As there is a large data set, loading the data in hadoop environment is required for fast processing.

i. Hadoop – is an open source structure for running distributed requests that process large amount of data. Hadoop is de facto standard for handling huge amount of unstructured data. Written in java, patabytes of data can be stored on the thousand of servers on hadoop. To scale up the performance nodes are added to the clusters for parallel processing.

ii. Sqoop Tool – is an self-acting tool to import and export data between mysql or oracle database to hdfs(hadoop distributed file system). It takes data from relational database run map reduce tasks on the data and restore it back to database.

iii. Apache HBase – is hadoop distributed, scalable big data store. Key/value pairs are stored in columnar form.

iv. Apache flume – is a distributed, reliable and available function for efficient collection, aggregation and moving large amount of data into hadoop distributed file system.

v. Apache Yarn – controls the data assimilate from apache flume into hadoop cluster.

Experiments and Results

A. Experimental Setup

Transformation and loading is implemted in eclipse on Linux. 4GB RAM processor is used for processing. Tool used is sqoop tool. Nodes taken for parallel processing in hadoop cluster are 2.

B. Experimental Results

1. Transformation

Transformation is performed on 11365863 (2.7144 GB) of patent records retrieved from USPTO patent database. The original table in figure 1 is patent inventor table which contains various duplicate records. This duplicacy is due to different formats of records i.e. some patent inventors' names are written in the form first, middle, last name while other records are in the form middle, first and last name. Also there are some names in patent inventor field that are written in different serial order.

Previously, the sorted neighbourhood method is applied on the dataset that sorts the database on a chosen specific key. This method takes more time to compare records as no pre-processing is performed before sorting which increases the computational time to compare the records. In this paper pre-processing is done before sorting the database i.e. field tokenization is done before database sorting which brings potentially matching records together and reduces the window size to compare the records which enhances the accuracy.

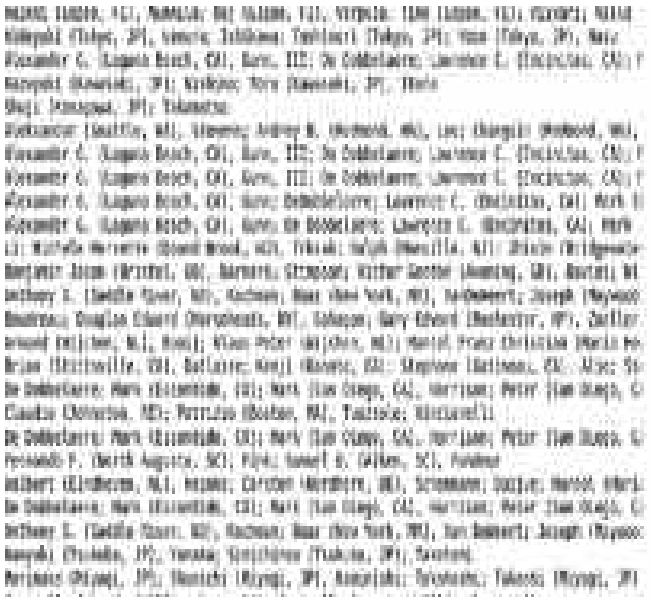

Figure 1: Dataset from patent database

i.e. first, the elements in the field are tokenized. For tokenizing the elements of the field delimiter taken is semicolon i.e. elements are separated and taken a token separated by semicolon. After tokenization sorting is performed on the field values shown in figure 2.

Figure 2: Token wise field sorting

After token wise sorting, database sorting is performed to bring records close to each other. As to transform and clean the database on the basis of patent inventor column, patent inventor is the key to sort database. Alphabetical sorting on patent inventor is performed on the database which brings the similar records together as shown in Figure 3.

Figure 3: Database after applying database sorting

The final step in the data transformation i.e. identify duplicate records and remove them. Matching is performed to figure out the replicate records. For record matching, string matching algorithm used is levenshtein string matching. In levenshtein string matching percentage of duplicacy of records is calculated from the result, records which are unique or we can say records which are not 100% matched are stored in the hash table from where the records are moved to the database table.

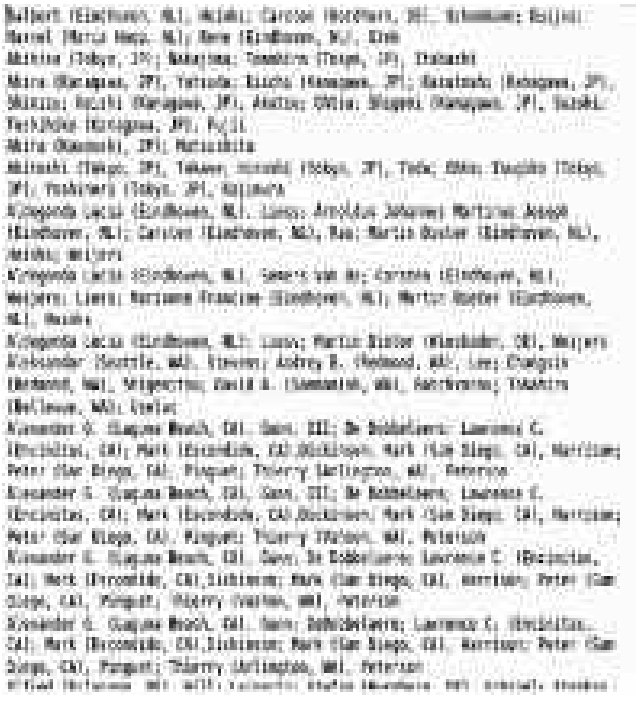

Figure 4: Dataset without Duplicacy

2. Loading

Loading the data to the warehouse is the final step / phase. In this phase transformed records are inserted from database to data warehouse. In this step, extracted and transformed data is written into the dimensional structures accessed by the end users and application systems. For loading purpose, sqoop tool is used. Sqoop tool is used to transfer the data between mysql to hadoop distributed file system. Patent table in mysql is shown in figure 5. Before moving the data to HDFS, patent_uspto table is created in the HDFS where we want to transfer our data and sqoop command to load data is executed (figure 6).

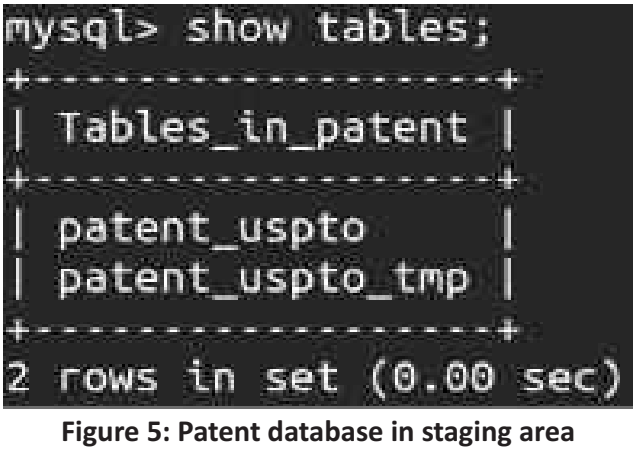

Figure 5: Patent database in staging area

Figure 6: Patent database in HDFS

Heavier datasets require larger number of nodes in Hadoop cluster, hence multinode hadoop cluster setup is done. In the setup multinode clusters composed of one master and one slave named as HadoopMaster and HadoopSlave1. For successful comeup of nodes web view of hadoop multinode cluster is viewed which is shown in figure 7. Active node in the figure is 2 that shows the successful completion of master and slave nodes.

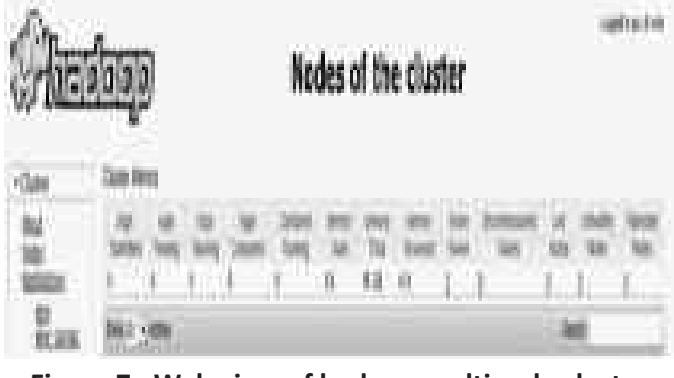

Figure 7: Web view of hadoop multinode cluster

Hadoop services on master and slave nodes are shown in figure 8a and 8b respectively.

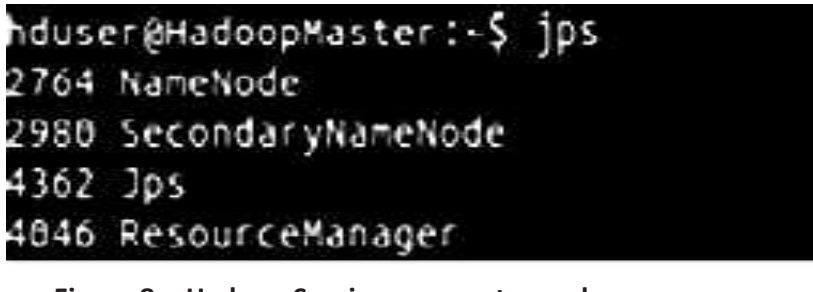

Figure 8a: Hadoop Services on master node

Figure 8b: Hadoop services on slave node

After setting the hadoop multinode cluster loading the patent_uspto table from mysql to hdfs is performed. Time taken by sqoop tool to load the data of 2.7144 GB in hadoop environment is 356.7999 seconds which is very less time.

Figure 9: Loading data in hdfs

The results show that the pre-processing steps for data transformation using token wise sorting, database sorting and levenshtein string matching bring more potentially matching records to a close neighbourhood for easy and fast detect and removal of duplicate records futhermore, to deal with such a huge data existing algorithm may fail for efficient performance in data warehouse hence, loading of data to hadoop environment is done.

Conclusion

As the data in the databases are increasing day by day data cleaning becomes a necessity. Structured and unstructured information is gained from the patent sites and stored in the databases. The work done in the field of data transformation to de-duplicate the records is described as well. This paper is aimed at finding a solution to clean the data in the database by removing the duplicate records for similar entities and load cleaned data into data warehouse. The records are first sorted token wise then database sorting is committed based on the chosen key and finally duplicates are removed by levenshtein distance matching, unique or deduplicate records are loaded into data warehouse.

References

1. Redman T. Data quality for the information age. Boston [u.a.]: Artech House; 1996.
2. Janna Olmos J, Kargul J. A quest for the artificial leaf. The International Journal of Biochemistry & Cell Biology. 2015;66:37-44.
3. Kimball R. Dealing with Dirty Data. DBMS: Artech House; 1996;9(10):55.
4. Batini C, Lenzerini M, Navathe S. A comparative analysis of methodologies for database schema integration. ACM Computing Surveys. 1986;18(4):323-364.
5. Hernández M, Stolfo S. The merge/purge problem for large databases. ACM SIGMOD Record. 1995;24(2):127-138.
6. Silberschatz A, Stonebraker M, Ullman J. Database research. ACM SIGMOD Record. 1996;25(1):52-63.
7. Fayyad U, Piatetsky-Shapiro G, Smyth P. From data mining to knowledge discovery in databases.AI Magazine, Fall, 1996, pp.37–54.
8. A. E. Monge and C. Elkan. The field matching problem: Algorithms and applications. In Proceedings of the Second International Conference on Knowledge Discovery and Data Mining (KDD-96), pages 267–270, Portland, OR, Aug. 1996.
9. Redman T. The impact of poor data quality on the typical enterprise. Communications of the ACM.

1998;41(2):79-82.

10. CALVANESE D, DE GIACOMO G, LENZERINI M, NARDI D, ROSATI R. DATA INTEGRATION IN DATA WAREHOUSING. International Journal of Cooperative Information Systems. 2001;10(03):237-271.
11. Simoudis, E., Livezey, B., & Kerber, R.(1995). Using recon for data cleaning. Proceedings of KDD (pp. 282-287).
12. Devlin B. Data warehouse. Reading, Mass. [u.a.]: Addison-Wesley; 2000.
13. Buckles B, Petry F. A fuzzy representation of data for relational databases. Fuzzy Sets and Systems. 1982;7(3):213-226.
14. Smith T, Waterman S. Identification of common molecular subsequences. Journal of Molecular Biology1981;147:195-195.
15. Jacqemin C, Royaute J. Retrieving terms and their variants in a lexicalized unification-based framework. Proc. of the ACM_SIGIR Conference on Research and Development in information retrieval pages 1994;132-141.
16. Friedland D, DeWitt D. Duplicate Record Elimination in Large Data Files. Ft. Belvoir: Defense Technical Information Center; 1981.

The Artificial Leaf: A Step towards Mimicking Photosynthesis

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Abstract

The unparalleled uncertainty in prices of conventional energy sources in last decades, and the stringent guidelines compulsory to reduce greenhouse gas emissions have generated apprehensions about the future of energy, and especially about the future of fossil fuels. The readily available traditional reserves of fossil fuels are dwindling and nobody is sure what energy alternative would be utilized in years to come. The side effects of massive use of fossil fuels by us are augmenting the problems of climate change, acidified oceans, oil spills, acid rains, and so on. Scientists around the globe are finding a ray of hope in biology that it can help us in harnessing the sun's energy in the form of synthesizing gasoline or other fuels. Sun's potential as a renewable energy source is quite vast. If one can develop a system to exploit solar energy to produce fuels on a large scale, then this will change the whole scenario of our future energy alternatives. However, the idea of harnessing energy from the sun is not new: the plants have been getting their energy from the sun through photosynthesis for billions of years. Therefore, there is a scientific challenge to construct an artificial leaf system, which can mimic the natural photosynthesis. Such a model will be able to capture and transform solar energy efficiently and store this energy in the form of chemical bonds of high energy density fuel such as hydrogen while at the same time, oxygen is produced from water. A lot of efforts were put in this direction, but finally in the year 2011, Daniel Nocera and his team succeeded in developing a low cost, playing-card-size coated-silicon sheet. This was named as 'artificial leaf'. It is capable in performing direct conversion of solar energy to synthetic fuels via photo-splitting of water to hydrogen and oxygen. Hydrogen can be used effectively as fuel as it has been already hailed as the fuel of the future. We have not won the battle of energy crisis yet, but it seems to be an effective step in the field of renewable energy for combating against present day's energy crisis in a sustainable and environmental friendly way. Further work on this concept may definitely bring worthwhile results for getting out some amicable solution to energy problem and to some extent to the problem of global warming.

Keywords: Artificial Leaf, Energy, Environment, Fuel, Photosynthesis, Sustainable

Introduction

The global economy is likely to consume even more energy in the future, especially with the rising energy demands of developing countries, but it will be increasingly difficult to supply this energy. Besides, the risk of climate change is also linked with the excessive use of fossil fuels. People have used cow-dung and firewood as the main sources of energy since time immemorial. Later, coal and fuels were used and more recently, nuclear and solar energy are taking their place. There has been an abrupt rise in the consumption of coal, fuels and its products during the last few decades and the existing stock of coal, fuels and other sources of energy are fast depleting. In this situation, the world is likely to become frightened over this energy crisis. We are facing an energy crisis for the first time in history not because we might run short of energy sources, but because we are using it in the uncontrolled way. Till now, the energy industries were judged by two metrics: its contribution to energy security and the cost of energy delivered to the consumer. To these two dimensions, one must add now a third one i.e. "its success in reducing the emission of greenhouse gases into the atmosphere; the major culprit being carbon dioxide."[1] Emission of carbon dioxide into the earth's atmosphere is primarily a result of burning fossil fuels for energy and it is thought to be the main cause of rising global temperatures. "We are already facing a catastrophic climate change due to release of carbon dioxide into the atmosphere due to burning of fossil fuels."[2] Scientific evidences support this assertion and these have been strengthened in recent years, suggesting a need for urgent and concerted action by all countries to prevent this ecological degradation (imbalance in eco system) on a massive scale.

"It has also been estimated that the solar insolation reaching our planet in one hour is equivalent to annual energy production by human population globally."[3] Solar energy is practically inexhaustible and solar fuels will provide an attractive green alternative for running our present day economies, as fossil fuels are getting depleted at an ever increasing pace, especially in the context of ever growing global energy demand. "The sun provides solar energy to our earth at a rate of 100 000 TW on annual basis."[4] As a result of ever-growing use or consumption of the oil, gas and coal, the levels of CO2 and other greenhouse gases in the atmosphere are increasing leading to the global climatic change. It is estimated that, "the global annual energy consumption rate will reach 20 TW (Tera watts) or even more by 2030, doubled by 2050 and tripled by the end of this century."[5-7] So there is a need to limit the use of fossil fuels and control their reserves just to avoid harmful consequences of its combustion. "If the total fossil fuels reserve is burnt, then the CO_2 level in the atmosphere and oceans would rise to values equivalent to those levels that existed on our planet long before humankind evolved."[8]

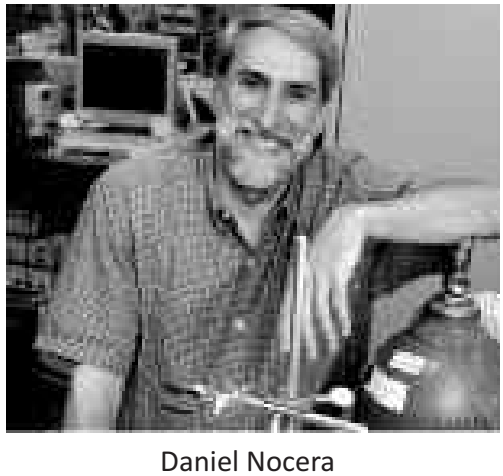
It seems that the challenge of the energy crisis and global warming has started casting their shadow on every section of humanity and this may be solved only if the whole mankind along with scientists and technologists are ready to face it. Different ways of renewable energy such as "hydropower, wind, wave, geothermal and biomass will not be able to supply energy at a mean annual rate of 20 TW, even if these are taken together."[7] The sun is considered the champion of all the energy sources, as it delivers energy to earth far in excess of needs of humankind. If solar energy is to be used as a major primary energy source, then it must be stored and transported to the end user on demand. We already have some ways to capture this solar energy. Today, photovoltaic solar cells trap 10%-20% of the energy of sunlight and transform it into electricity. As electricity is difficult to store on a large scale, the effort to store sunlight's energy in terms of chemical fuels has become one of the greatest challenges of the 21st century. "Harvesting sunlight is a trick plants mastered more than a billion years ago in the form of photosynthesis."[9]

Solar energy will become a practical and widespread component of our energy mix, and for this purpose, new technologies to store and transport it are of crucial importance, so that this energy is made available to those areas, when there is little or no sunlight. Solar fuels like hydrogen address this challenge as in this case, energy from the sun is directly stored in the chemical bonds of the fuels (Hydrogen). Solar fuels can be also easily transported using existing distribution

networks by pipeline, road, rail or sea. This solar fuel can also be combined with established fuel cell technologies, which can transform fuel to electricity and heat, so as to power a building or a small locality. Other than this, an especially attractive approach is to store solar energy in the form of chemical bonds as done in natural photosynthesis. However, a technology is required, which has year-round average conversion efficiency relatively higher than that is currently available by natural photosynthesis so that land area requirements are reduced. Meeting the energy demand of the world in a sustainable manner will not only require increase in the energy efficiency and new methods of using existing carbon-based fuels but also the task of developing a new carbon-neutral energy.

Solar energy seems to be a key for sustainable energy supply in all scenarios. If we wish to develop a sustainable future, we will have to change drastically our production system, may be in industrial production processes or in our own living environment. We will have to deal with these changes and we are all going to get benefits from these. The green plant life around us has had a perfectly developed system for years together without any break for absorbing sunlight and using this energy to transform water and carbon dioxide into oxygen and carbohydrates. The energy from the sun is stored in the form of chemical bonds of carbohydrates, which will be ready source of energy for the plants to use it later. Photosynthesis is conceptually very simple but mechanistically much complex process as some of its important parts still remain mysterious. Scientists have been trying to understand the secret of this complex biological system for many decades, but have not been very successful in spite of fact that the level of sophistication has developed to a great extent. It has become even more important to attempt to imitate the process of photosynthesis, which has been perfected by nature. Here, the process of artificial photosynthesis enters the scene. Much of the work in the area of artificial photosynthesis has been focused on splitting water into its constituent parts i.e. hydrogen and oxygen. The oxygen so generated can be released into the atmosphere (as it is done in natural photosynthesis), and the other component hydrogen could be put to generate energy. If hydrogen is handled effectively, it has a huge potential to be used in fuel cells that can generate electricity without any harmful byproducts, or to combine it with some other materials to make more useful products. Another way is that it can be treated with nitrogen under modest conditions to create low cost fertilizers.

Most of the energy we use comes from photosynthesis. Green plants store energy from the sun in chemical bonds in the form of biomass. Humans and animals are fed on this in the form of cereals, vegetables, fruits, grass, etc. or energy from burning these products; plants, firewood, peat, coal, oil, natural gas, and ethanol, etc. Although some progress has been made in mimicking photosynthesis in artificial system, researchers have not yet developed components that are efficient as well as robust; for incorporation into a working system for capturing and storing solar energy in chemical bonds on a large scale. Khaselev and Turner reported a complete system that showed a major advance in this direction as "it stored 12% of the incident solar energy as fuel, compared with 1% of energy stored as biomass in real leaves."[10] But it has certain limitations that it costs more than 25 times, which is too much to be competitive, and also its performance dropped off only within 20 hours of sunshine. Therefore, the most "attractive method for this energy conversion and storage is only in the form of chemical bonds, by production of low cost solar fuels."[7] This has been successfully achieved by developing an artificial leaf system and credit for this development goes to Nocera and his team.



Daniel Nocera

In the early eighties, Nocera decided that the chemistry of green plants (particularly leaves) was the likeliest place to give a reasonable answer to civilizations for their long term energy shortage problem. We have depended on fossil fuels for past two centuries or so, but now it is not working out so well. Nocera wanted to know what worked for two billion years before thatv He focused his research on finding out a way to inexpensively replicate solar energy conversion as performed by plants. Basically, he started working on proton-coupled electron transfer. He decided to understand the fundamental science involved in the process of photosynthesis. Later, in the year 2011, he announced a tangible breakthrough in the form of a low cost, playing-card-size coated-silicon sheet. This sheet on placing in a glass of tap water exposed to sunlight split water into hydrogen and oxygen. He showed that the gas bubbles were streaming from the sheet. This gas could easily be collected and either burned or used to power a fuel cell and he named this sheet as "artificial" leaf. Nocera's discovery might provide an answer to the presently existing energy puzzle. It was claimed that artificial leaves could enable people anywhere to live without being connected to any power grid. He also predicted with a stress that "we will be able to control our own energy within a few decades, and that this artificial leaf would enable us to turn a home into a self-sufficient power station. The major advantage of this leaf is that it stores solar energy in the form of a fuel, rather than a battery and therefore, it is potentially more versatile. It is less expensive also to acquire, maintain and exploit as far as user's energy requirements are minimal."[11] The artificial leaf provides an inexpensive means for direct solar to fuel conversion process with low-cost system engineering and manufacturing requirements.[12]

Natural photosynthesis represents one of the most fundamental processes that is responsible for sustaining life on earth. It is a process used by plants and other organisms to transform light energy from the sun into chemical energy, which can be later released to fuel the activities of organisms. This chemical energy is stored in the form of carbohydrate molecules, such as sugars, which are synthesized from carbon dioxide and water. These carbohydrate molecules act as the source of energy. Photosynthesis is the ultimate source of almost all the fuels we are using today. The process of photosynthesis maintains oxygen levels in atmosphere and "supplies organic compounds and most of the energy necessary for life on Earth."13 The photosynthetic reaction can be divided into two half-reactions and these are: oxidation and reduction. Both these reactions are essential for producing fuels. Water molecules are photo-oxidized to release oxygen and protons during plant photosynthesis. The second stage of photosynthesis, which is also known as the Calvin-Benson cycle, is not a light dependent reaction. This step transforms carbon dioxide into high energy product glucose (fuel). Researchers in the area of artificial photosynthesis are attempting to develop newer and efficient photocatalysts that are able to perform both these reactions. "The protons resulting from water splitting in the first step can be used for hydrogen production. Such catalysts must be able to react quickly and absorb a large percentage of the incident solar photons."[14]

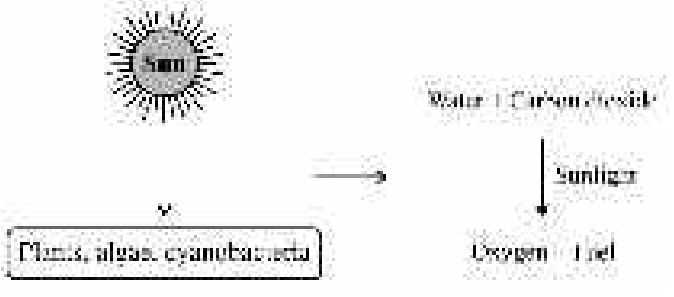


Figure 1: Schematic presentation for process of photosynthesis

An overall equation of photosynthesis that occurs in plants:

$$6\,CO_2 + 6\,H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6\,O_2 \quad (1)$$

Carbon dioxide Water Sugar Oxygen

This process is supported by a light-driven water splitting reaction, which occurs in an enzyme found in plants, algae and cyanobacteria known as photo system II (PSII).[15,16] Initially, solar energy is absorbed by chlorophyll and other pigments and then it is transferred efficiently to the PSII reaction centre, where charge separation process takes place. The conversion

of light energy into electrical energy occurs at a thermodynamic efficiency of greater than 70%. In this case, a radical pair state P680+Pheo- is generated. Here P680 is chlorophyll a molecule and Pheo is pheophytin a molecule. The redox potential of P680+ is very oxidizing, and it has been estimated to be more than +1νV, while for Pheo-, it is approximately - 0.5νV. As the latter potential is sufficiently negative, it could be utilized to drive the formation of hydrogen. But, this reducing equivalent is passed through an electron transport chain to PSI, where it is excited by the energy of a second red photon absorbed by chlorophyll molecule. It is called P700, and gives a redox potential of - 0.7νV or more. This way, sufficient energy is available to drive the fixation of carbon dioxide. The generation of the reduced hydrogen carrier, nicotinamide adenine dinucleotide phosphate ($NADPH_2$) is required for this purpose apart from energy-rich molecule adenosine tri-phosphate (ATP) formed by the release of some energy during electron transfer from PSII to PSI.[17]

The $P680^+$ species generated in PSII are responsible for driving the splitting of water. In this process, electrons are extracted from a catalytic centre composed of a cluster of four manganese ions and a calcium ion. The process of splitting of water into oxygen and reducing equivalents (4 H^+) is a four-electron process and therefore, PSII must absorb four photons (4 hν) to drive this reaction.

$$2\,H_2O \xrightarrow{4h\nu} O_2 + 4\,H^+ + 4\,e^- \qquad (2)$$

The reducing equivalents leave PSII in the form of plastoquinol (PQH_2), while the oxygen is released into the atmosphere.

$$2\,H_2O + 2\,PQ \longrightarrow O_2 + 2\,PQH_2 \qquad (3)$$

The efficiency of this reaction is relatively high i.e. almost 50%, when this reaction is driven by the energy of red photons, but it decreases to approximately 30% on the account that light is absorbed across the whole solar spectrum. The reaction can only proceed continuously in photosynthetic organisms, when the PQH_2 molecules are oxidized by the light absorbed by PSI. As a result, hydrogen is allowed to be transferred to carbon dioxide.

The photosynthetic reaction centres of PSII, PSI and anoxygenic photosynthetic bacteria (organisms that do not split water) are highly efficient molecular photovoltaic nano machines. These use light energy and result in electrical charge separation. "The organization of the electron carriers in these Nano-molecular devices is such that forward energy-storing reactions are facilitated and backward energy-releasing reactions are minimized. These photosynthetic reaction centers are structurally and functionally have much similarity. Some aspects of their design should make them active enough to be incorporated into an artificial photosynthetic device, while are very similar to certain types of existing photovoltaic schemes."[18]

The whole process during photosynthesis can be summarized as follows: First, plants absorb sunlight, water, and carbon dioxide. Then they utilize two protein complexes called "photo system I and II to split water and synthesize fuel."[19] Initially, energy in sunlight splits two water molecules into four hydrogen ions (H^+), four electrons, and a molecule of oxygen in photo system II. The O_2 is flushed away as waste and the protons and electrons are sent to photo system I, where they are used to energize the coenzyme NADP to NADPH, which in turn is used to assist in synthesizing sugars in a key series of metabolic steps.

The history of artificial photosynthesis goes back to 1912, but the momentum was not gained by this field until 1972, when the requirements of a device to use sunlight and use "this energy to split water into oxygen and hydrogen was outlined"[20] Artificial photosynthesis is a chemical process that mimics the natural process of photosynthesis or a process which can harvest sunlight and use this energy to transform water and carbon dioxide into fuels. In general, the term artificial photosynthesis is quite commonly used to refer to any system for capturing and storing the energy from sunlight in the chemical bonds of solar fuel. The main research area concerning artificial photosynthesis is photocatalytic water splitting, which converts water into hydrogen ions and oxygen. The production of liquid fuels by artificial photosynthesis offers a promising source of a renewable and carbon-neutral source of energy. Moreover, it would not contribute to the global

warming also; that is the major drawback of burning oil and coal as fuel. The idea was to improve upon the process and develop a single platform light-harvesting systems that can do both the jobs; capture solar photons and catalytic systems to oxidize water; or in other words, an artificial leaf seems to provide such a solution. Artificial leaf certainly uses the same basic steps like natural photosynthesis and these are:

- Sun Light harvesting,
- Charge separation,
- Water splitting and
- Fuel production.

Scientists first succeeded in producing hydrogen and oxygen by splitting water using artificial photosynthesis in the 1950s, and thereafter, there were many breakthroughs using both biological and physical systems.[21] However, these systems were not economically viable, efficient or durable enough for large scale use. In 1998, John Turner built a device with a size of a matchbox and "it was found to be 12 times as efficient as a leaf."[22] But this system is based on some rare and expensive materials and therefore, might do better for military or satellite applications only but not much useful to power civilization. Another major problem is that such a device for water-splitting reaction is highly corrosive in nature. Interestingly, plants handle this situation by constantly rebuilding their photosynthetic machinery. The lifetime estimated for Turner's solar fuel cell was only 20 hours. Noble metals used in such systems are best catalysts, but these are scarce in supply, and that's the big pitfall in the game.

Nocera and Kanan[23] tried to avoid this issue by using a catalyst which contained some low cost and more copious elements like cobalt and phosphate. This catalyst has the ability to split water into oxygen and protons using sunlight, and could be coupled to a hydrogen-producing catalyst such as platinum. Surprisingly, the catalyst was broken down during catalysis, but it showed an ability for self-repair, as in the case of natural photosynthesis. This catalyst design was considered a major breakthrough in the area of artificial photosynthesis. The development of an inexpensive and efficient prototype artificial leaf was announced in March 2011, but the issue of the long-term stability of such systems has yet to be established.

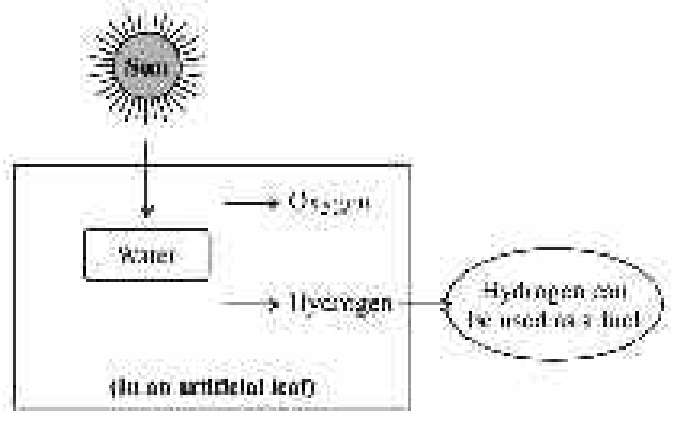


Figure 2: Artificial photosynthesis

Nocera called this process artificial photosynthesis and it could be described more correctly as solar-powered electrolysis of water, i.e. to split water into hydrogen and oxygen electrochemically using energy from the sun. Once the water has been split into hydrogen and oxygen, the hydrogen generated is harvested.[24] Although natural photosynthesis is feeding the whole world, even then it is relatively much inefficient. Many plants transform only 1% of the energy in the form of sunlight falling on them. On the other hand, sunlight is plentiful, and the total energy in the photons that strike the earth each hour is very high, but not used to the desired extent.

For an ideal solar fuel process or an artificial leaf; the requirements of the proposed system are:

- Earth-abundant materials (to make it cost effective),
- No wires are required and
- Direct solar-to-fuel process

Two earth abundant catalysts have been discovered that promote the oxygen evolving reaction (OER) and hydrogen evolving reaction (HER). These catalysts are able to operate under benign conditions in water at pH 7 and 1 atm has enabled the construction of the artificial leaf. This leaf contains a silicon wafer, coated with the two respective catalysts: OER and HER catalysts. When this artificial leaf is immersed in water and kept in sunlight, it causes efficient water splitting and that too

with no wires. This system does not rely on a membrane also. Thus, "the artificial leaf provides a means for an inexpensive and distributing direct solar to fuel conversion process with low cost systems engineering and manufacturing requirements based on a device composed of earth-abundant materials."[12]

This device comprises a silicon wafer coated with catalysts based on Mn, Co and Ni, which are self-healing. The artificial leaf is a buried junction, where the rectifying junction is protected from solution (or buried). In a buried junction device, catalysis is separated from current rectification, charge separation, and photovoltage generation, which occur at the internal junction, while water splitting catalysis is combined with charge separation, current rectification, and photovoltage generation in a conventional solution photoelectrochemical cell (PEC). The buried junction PEC cell is free from many of the design limitations of a traditional PECs. A link was found between the kinetic profile of the water splitting catalysis and the photovoltaic power curves, so that higher efficiencies may be achieved. "Solar to fuel efficiencies as high as 10% have now been accomplished."[25] Nocera showed that the artificial leaf worked continuously for three days in laboratory. Nocera has a full hope that a prototype artificial leaf might be ready for use by society within a few years.[26]

The rising height of science and dedication of our scientist for welfare of society and humanity to maintain the sustainability of our planet earth is worthy of appreciation. They were able to construct a low cost and small sized device named as artificial leaf, which can produce synthetic fuel in an environmental friendly manner in the presence of sunlight. We can use the water of ocean to generate hydrogen by photosplitting and then burn this hydrogen at a power plant (in fuel cells) to produce electricity. The final product of burning hydrogen is water again. Isn't it quite amazingv But it's not a time for clapping yet, because this is a first step only and now we are on the right track to solve the energy crisis, but the journey will continue for some more years to achieve the final goal.

References

1. Browne J. The energy crisis and climate change, Symposium. 2009.
2. Barber J, Tran P. From natural to artificial photosynthesis. Journal of The Royal Society Interface. 2013;10(81):20120984-20120984.
3. Janna Olmos J, Kargul J. A quest for the artificial leaf. The International Journal of Biochemistry & Cell Biology. 2015;66:37-44.
4. Barber J. Biological solar energy. Phil. Trans. Royal Society. 2007;365:1007–1023.
5. Hoffert M, Caldeira K, Jain A. Energy implications of future stabilization of atmospheric CO2 content. Nature. Final report. 1997Jan;395:881-884.
6. Nakicenovic N, Swart R. Special report on emissions scenarios. Washington, DC: Intergovernmental panel on climate change. 2000; 48–55.
7. Lewis NS, Nocera DG. Powering the planet: Chemical defys in solar energy utilization. PNAS. 2006;103(43):15729–15735.
8. Pachauri RK, Reisinger A. IPCC, Climate Change 2007: Synthesis Report. Contribution of working groups I, II and III to the fourth assessment report of the intergovernmental panel on climate change. IPCC. Geneva. Switzerland. 2007;104.
9. eNREE. A quarterly electronic newsletter on renewable energy and environment. 2015; 11(4):1-30.
10. Khaselev O. A Monolithic Photovoltaic-Photoelectrochemical Device for Hydrogen Production via Water Splitting. Science. 1998;280(5362):425–7.
11. Owen D. The Artificial Leaf. The New Yorker. 2012; 74.
12. Nocera DG. The artificial leaf. Distinguished lecture for celebrating PolyU's 75th anniversary, Department of applied biology and chemical technology. The Hong Kong polytechnic university. 2012.
13. Bryant DA, Frigaard N-U. Prokaryotic photosynthesis and phototrophy illuminated.

Trends in Microbiology. 2006;14(11):488–96.

14. Yarris L. Turning sunlight into liquid fuels: Berkeley lab researchers create a nano-sized photocatalyst for artificial photosynthesis. Berkeley lab news center. Lawrence Berkeley National Laboratory. 2009.
15. Barber J. Photosystem II: the engine of life. Quarterly Reviews of Biophysics. 2003;36(1) :71–89.
16. Barber J. Photosystem II: an enzyme of global significance. Biochemical Society Transactions. 2006Jan;34(5):619–31.
17. Blankenship RE. Molecular Mechanisms of Photosynthesis. Blackwell Science Ltd, Oxford. London. 2002;1-22.
18. Graetzel M. Solar energy conversion by dye-sensitized photovoltaic cells. Inorg. Chemistry. 2005;44:6841–6851.
19. Service RF. Turning over a new leaf. Science. 2011;334: 925-927.
20. Fujishima A, Honda K. Electrochemical Photolysis of Water at a Semiconductor Electrode. Nature. 1972;238(5358):37–8.
21. Heeger AJ. Solar fuels and artificial photosynthesis, science and innovation to change our future energy options. The Royal Society of Chemistry. 2012;18.
22. Regalado A. Reinventing the leaf. Science. Amer. 2010; 303:86 – 89.
23. Kanan MW, Nocera DG. ChemInform Abstract: In situ Formation of an Oxygen-Evolving Catalyst in Neutral Water Containing Phosphate and Co_2. ChemInform. 2008;39 (47).
24. Marshall J. Solar energy: Springtime for the artificial leaf. Nature. 2014Apr;510(7503) :22–4.
25. Daniel Nocera: Maverick Inventor of the Artificial Leaf ... [Internet]. [cited 2017Jul15]. Available from: http://www.bing.com/crvIG≤ 414EF5FEF4874E9B907C832D5E8C9394&CID ≤10DDBE42FF3063022164B482FE36623F&rd ≤1&h≤fNDdlIEcDc9cWP1-v60m478s OFZrZavTqo-jQkxryhA&v≤1&r≤http%3a%2f% 2fnews.nationalgeographic.com%2fnews%2finn ovators%2f2014%2f05%2f140519-nocera-chemistry-artificial-leaf-solar-renewable-energy%2f&p≤DevEx, 5063.1
26. Nair P. Profile of Daniel G. Nocera. PNAS. 2012; 109(1):15-17.

Proteomics Approaches for the Identification and Characterization of Proteins

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Abstract

Over the last two decades, protein analysis has come to be an important tool for finding out any type of alteration in food products and has changed entire scenario of biological sciences. Analyzing the food proteome at any particular time is quite difficult and complex. A typical proteomics work flow includes extraction of protein, protein or peptide separation and quantification, identification of protein and data analysis and interpretation explanation. Sample preparation has a deep effect on the consequence of protein and peptide separation and their analysis. These measures need to be compatible with subsequent posterior by 2-dimensional electrophoresis and mass spectrometry (LC-MS/MS) methods. Using these approaches, one can find the type of protein expression, level of expression, consequence of a variety of factors affecting protein expression and alteration in protein expression and alteration in protein expression.

Keywords: TOF, Proteomics, Two-dimensional electrophoresis, Mass spectrometry, MALDI

Introduction

"The use of proteomics approaches is a powerful tool in food science in terms of process optimization and monitoring, quality, traceability, safety, and nutritional assessment."[9] Proteins, including peptides, are one of the major groups of food components, and they are found in various organisms of both vegetal and animal origin. Peptides are also obtained during technological procedures such as fermentation and storage of foods. Moreover, "many experiments involve enzymatic hydrolysis of protein from food resources such as milk, meat, fish, egg, or plant to produce a variety of peptides."[6]

"Proteins are specific molecules indicating the existence of a chemical or a physical process. Proteins can be analyzed through a variety of techniques. Among them, polyacrylamide gel electrophoresis (PAGE) is a generally favored technique for rapid analysis"[3,11,12] "due to its validity and simplicity."[1]

Polyacrylamide gel electrophoresis (PAGE) is one of the most reliable methods

available for the separation of protein in the complex mixture and for assessing protein purity. The variations characterized by PAGE have been described in three categories "(i) altered electrophoretic mobility (ii) loss/gain of protein bands, and (iii) altered level of specific protein."[10] Almost all analytical electrophoresis of proteins is carried out by polyacrylamide gels under conditions that ensure the dissociation of the proteins into their individual polypeptide subunits and that minimize aggregation. Strong anionic detergent like sodium dodecyl sulphate is utilized in combination with reducing agent and heat to dissociate the proteins before they are loaded on gel. By using marker of the known molecular weight, it is possible to estimate the molecular weight of the polypeptide chain under study. In most of the cases polyacrylamide gel electrophoresis is carried out with discontinuous buffer system in which the buffer in the reservoir is of different pH and ionic strength from the buffer used to cast the gel. The SDS polypeptide complexes in the sample that is applied to the gel are swept between the electrodes. After migration through the stacking gel of high porosity, the complexes are deposited in an extremely thin zone or stack on the surface of resolving gel. The ability of discontinuous buffer systems to concentrate all the complexes in the sample into an extremely small volume greatly increases the resolution of SDS polyacrylamide gels.

In SDS-PAGE method protein mixture is denatured by warming up at 95-100°C in the presence of excess SDS and a thiol reagent. Under these conditions, all proteins are dissociated into their individual polypeptide subunits. Thus proteins are separated in polyacrylamide gels of the correct porosity according to their size. Electrophoretic mobilities of the individual protein change disproportionately as either the pH or the concentration of the acrylamide changes.

Staining of gels aims at developing an efficient staining of proteins with minimum background noise to have a clear visualization of proteins on the gel, while the destaining process lessens background noise that might interfere with the protein bands of interest. Coomassie Brilliant Blue R-250 is the most frequently employed staining dye for the detection of proteins. It is the method of choice if SDS is utilized in the electrophoresis of proteins and is sensitive for a range of 0.5 to 20.0 μg of protein. Within this range, it also complies with Beer-Lambert law and thus can be utilized quantitatively as well as qualitatively.[7] The major problem is the length of time needed for the procedure and the requirement for the destaining. Overstraining results in a significant retention of stain within the gel which might obliterate the bands. The length of the time for staining must be carefully monitored and could range from 20 minutes to several hours. Furthermore, the intensity of blue coloration developed during the staining process is directly proportional to the quantity of protein present in the sample. The dye penetrates the entire gel; however, it only sticks permanently to proteins. Excess dye is washed out by de-staining with acetic acid/methanol with agitation. The original dye front consisting of bromophenol blue dye disappears during the process.

Silver staining is a more sensitive staining technique and can detect 1 ng to 1 μg protein. This technique is based on the precipitation of silver chloride in the proteins with the silver ions in the solution of silver nitrate. The time of exposure to the silver nitrate is also important and must be standardized using a wide range of exposure time. One of the negative aspects of 1-D analysis is that peptides with almost similar molecular weight are represented by a single band on the gel, due to lower resolution power. To overcome this problem and to get better resolution 2-dimensional analysis is carried out. In 2-D analysis proteins or peptides are first separated on the basis of their isoelectric point and then proteins are separated on the basis of their molecular weight. Using this approach two proteins with the same molecular weight provide separate spot on the gel due to difference in their Isoelectric point values.

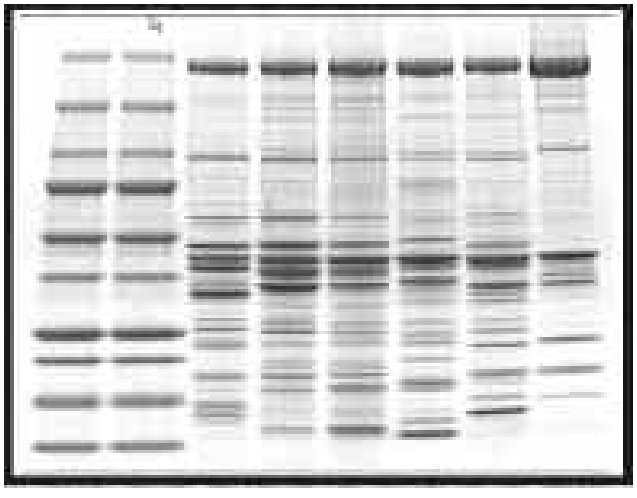

Figure 1: One dimensional gel electrophoresis: Extraction of proteins according to their molecular weight

Isoelectric Focusing (IEF)

IEF is an electrophoretic technique that splits proteins according to their isoelectric position (pI). Proteins are amphoteric molecules; they carry either positive, negative or zero net charge, depending on the surroundings. The net charge of the protein is the sum of all the -ve and +ve charges of its amino acids side chains and amino and carboxy termini. The isoelectric position (pI) is a specific pH at which the net charge of protein is zero. Proteins are positively charged at pH values below their pI and negatively charged at pH values above their pI.

The presence of pH gradient is significant for the IEF technique. In a pH gradient, under the influence of an electric field, a protein will move to the position in the gradient where its net charge is zero. A protein with a +ve net charge will migrate towards the cathode, becoming progressively less negatively charged as it moves through the pH gradient until it reaches its pI. A protein with a -ve net charge will migrate towards the anode, becoming less negatively charged until it also reaches zero net charge. If a protein should diffuse away from its pI, it straight away gains charge and migrates back. This is the focusing effect of IEF, which concentrates proteins on their pIs and allows proteins to be seperated on the basis of very little charge differences. The resolutions of protein are determined by the slope of the pH gradient and the electric field potency.

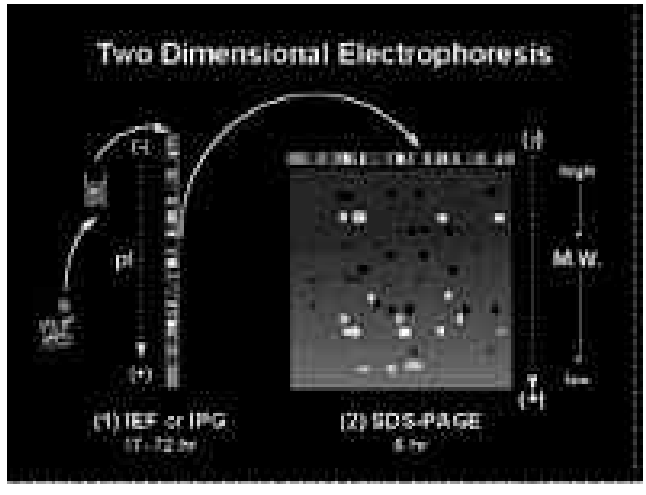

Figure 2 : Isoelectric focusing and separation of polypeptides on the basis of their molecular weights

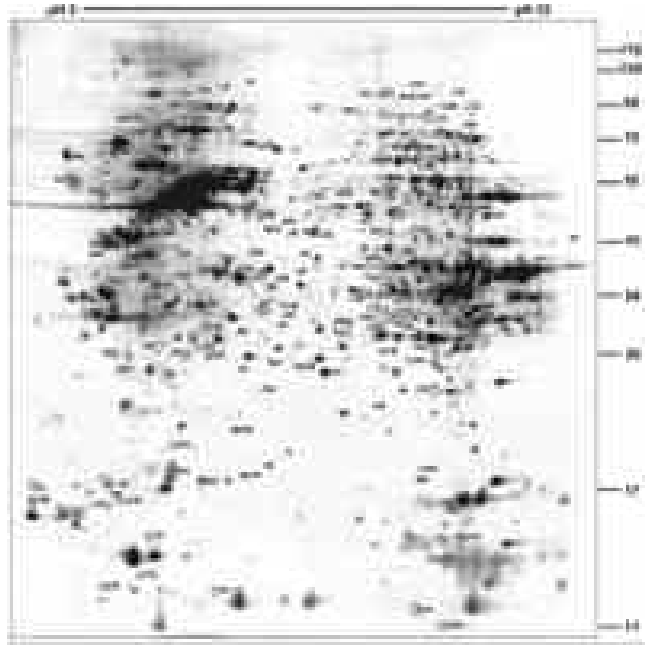

Figure 3: Two Dimensional protein separations: Each spot represents a single protein with specific pI value and molecular weight

Further Analysis of Protein Spots

1. Spot Picking – "The Ettan Spot Picker is a robotic system that mechanically picks protein spots from stained or unstained gels by means of a pick list from the image analysis, and transfers them into microplates. The gels are positioned into the

instrument under liquid; the camera detects the reference markers. Control software converts spot pixels co-ordinates into picking co-ordinates and the Ettan Spot Picker selects and transfers 96-well microplates."

2. Digestion of proteins – "The gel plugs are automatically digested in the Ettan Digester, the supernatant peptides are mixed with MALDI matrix material and spotted onto MALDI slides using the Ettan Spotter."

MALDI-ToF Mass Spectrometry

The usefulness of MALDI for protein and peptide analysis lies in its ability to provide extremely precise molecular weight information on intact molecules. The ability to generate such precise information can be very useful utilization for protein identification and characterization. Protein identification can also be carried out through an analysis of the protein's proteolytic peptide fragments in the gas phase; fragment ions produced inside MALDI mass spectrometers via collision-induced dissociation yield information about the main structure and modifications. Tandem mass spectrometry (nth series) (MSn) experiments, previously allowed with quadrupole and ion trap mass spectrometers are now attainable with MALDI sources (known as post source decay or PSD). While the MALDI mass spectrometer is an authoritative tool for the precise mass determination of peptide mixtures, obtaining precise mass measurements is highly dependent upon the sample and the sample preparation. Acquiring optimum MALDI data depends on the selection of suitable matrices and solvents, the functional and structural properties of the analyte, sample purity, and how the sample is prepared on the MALDI sample plate. It must be noted that as the solvent matrix is the medium by which the analyte will be transported to the gas phase providing the condition that make the ionization possible, the contamination of the sample with excessive salt (>10mM) will affect these condition and lead to reduced sensitivity.

Dialysis and reversed-phase liquid chromatography, or exchange chromatography are useful techniques for purifying samples of such contaminants prior to mass spectral analysis.

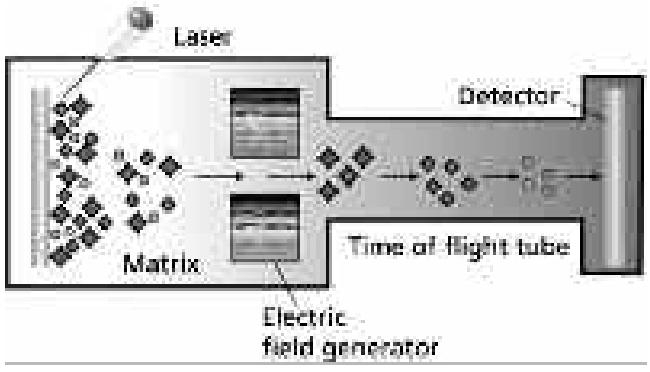

Figure 4: MALDI-ToF Mass spectrometry: General Mechanism

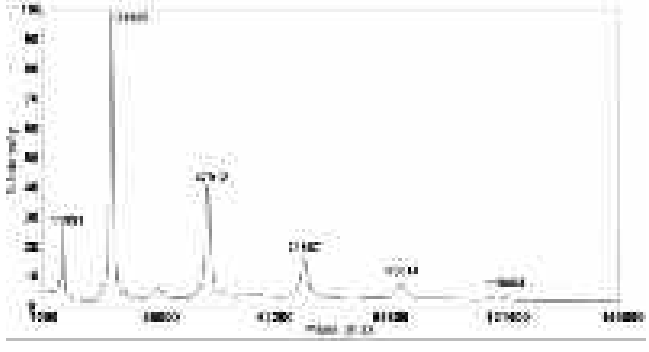

Figure 5: MALDI-TOF linear mass spectrum of intact protein

Protein Succession Analysis

"Amino acid sequence information can be obtained by one of several methods using MALDIMS. The first is called protein mass mapping which consists of the site-specific enzymatic or chemical degradation of a protein followed by mass spectrometric analysis of the released peptides. Owing to the complexity of mixtures generated during proteolysis, MALDI/TOF MS is most ideally suited for such analyses. The traditional analytical techniques used to characterize the released peptides consist of high-performance liquid chromatography (HPLC) or gel electrophoresis followed by N-terminal (Edman) sequencing and/or amino acid analysis." However, such techniques are considerably more time-consuming and in some cases are not capable of separating individual peptides because of their low resolution. As a result, high-resolution MALDI/TOF analysis can provide for a more rapid, precise, and highly sensitive analysis of these complex peptide mixtures. The purpose of protein mass mapping is

not to sequence the entire protein but to generate information that can be utilized in protein data base search either to identify the protein or determine whether the protein is novel. Protein identification via data base searching is facilitated by the accurate m/z values of the digest fragments, the specificity of the enzyme utilized, and the accurate m/z of the intact protein. Protein data bases such as Swiss Prot, NCBInr, OWL, Genepept are available on the internet. The type of protease used in the mass mapping approach is an endoprotease, a protease which cleaves internal residues. An extended version of this technique follows the endoproteolytic digestion with an exoprotease, which cleaves successively from either the n-terminal or c-terminal side of a peptide or protein. The result is a mass spectrum with peptides differing by one amino acid residue. The mass difference between ion signals determines the identity of the released amino acid and typically provides a succession tag on the order of 1–12 amino acids. This technique further increases the possibility of a database ''hit'' by providing one more piece of valuable information, a partial sequence tag.

One more MALDI based approach that provides amino acid sequence information on peptides depends on the fragmentation of the ions in the field-free drift region (between the ion source and the detector) of the TOF mass analyzer. This fragmentation, referred to as PSD, is due to collisions between analyte ions and neutral matrix molecules or residual gas molecules during desorption and acceleration stage. Initially, these fragments have the same velocities as their precursor ion. As a result, in a linear TOF mass analyzer these fragments arrive at the detector at the same time as their precursor ion and are therefore not shown in the mass spectrum. In a reflectron TOF mass analyzer, however, these fragments penetrate the reflectron at different depths and are therefore spatially differentiated, meaning that individual fragments arrive at the reflectron detector at different flight times. As a result, these fragments are represented in the mass spectrum providing valuable structural information. Amino acid sequencing by PSD has become a popular technique for sequencing peptides and is now available on most commercial MALDI reflectron instruments."

Another approach to getting peptide sequence data from MALDI is MSn within an FTMS analyzer cell. The advantage of FTMS, in addition to its high resolution capabilities, is its ability to carry out MSn experiments. Dissociation of the precursor ion can be accomplished by the introduction of a collision gas but it has very little specificity and selectivity. The results may be misleading if a complicated digestion mixture is presented.

This difficulty can be resolved by using MALDI PSD MS/MS to generate and record meta-stable fragment ions. "The aid of an extraction technique, usually HPLC, is sometimes needed before the MALDI analysis. This protein modification characterization approach has been employed by several groups to identify and sequence either glycoproteins or phosphoprotein." [4,5,8,13,14]

References

1. Ahmad F, Slinkard A. Genetic relationships in the genus Cicer L. as revealed by polyacrylamide gel electrophoresis of seed storage proteins. Theoretical and Applied Genetics. 1992;84-84(5-6).
2. Annan RS, Carr SA. Phosphopeptide Analysis by Matrix-Assisted Laser Desorption Time-of-Flight Mass Spectrometry. Analytical Chemistry. 1996;68(19):3413–21.
3. Ferguson JM, Grabe DF. Identification of Cultivars of Perennial Ryegrass by SDS-PAGE of Seed Proteins1. Crop Science. 1986;26(1):170.
4. Huberty MC, Vath JE, Yu W, Martin SA. Site-specific carbohydrate identification in recombinant proteins using MALD-TOF MS. Analytical Chemistry. 1993;65(20):2791–800.
5. Machold J, Utkin Y, Kirsch D, Kaufmann R, Tsetlin V, Hucho F. Photolabeling reveals the proximity of the alpha-neurotoxin binding site to the M2 helix of the ion channel in the nicotinic acetylcholine receptor. Proceedings of the National Academy of Sciences. 1995Jan;92(16):7282–6.

6. Minkiewicz, P., Dziuba, J., Darewicz, M., Iwaniak, A., Dziuba, M. and Nalecz, D. (2008). Food peptidomics. Food Technol Biotechnol., 46: 1–10.

7. Morrissey JH. Silver stain for proteins in polyacrylamide gels: A modified procedure with enhanced uniform sensitivity. Analytical Biochemistry. 1981;117(2):307–10.

8. Neville DCA, Townsend RR, Rozanas CR, Verkman AS, Price EM, Gruis DB. Evidence for phosphorylation of serine 753 in CFTR using a novel metal-ion affinity resin and matrix-assisted laser desorption mass spectrometry. Protein Science. 2008;6(11):2436–45.

9. Pedreschi, R., Hertogi, M., Lilley, K.S. and Nicolaïl, B. (2010). Proteomics for the food industry: opportunities and challenges. Crit Rev Food Sci Nutr, 50:680–692.

10. Rani V, Raina SN. Genetic fidelity of organized meristem-derived micropropagated plants: A critical reappraisal. In Vitro Cellular & Developmental Biology - Plant. 2000;36(5): 319–30.

11. Raymond J, Inquello V, Azanza J. The seed proteins of sunflower: Comparative studies of cultivars. Phytochemistry. 1991;30(9): 2849–56.

12. Smith J, Smith O. Environmental effects on zein chromatograms of maize inbred lines revealed by reversed-phase high-performance liquid chromatography. Theoretical and Applied Genetics. 1986;71(4).

13. Knapp DR. Mass Spectrometry in the Biological Sciences A. L. Burlingame and S. A. Carr, Editors. Journal of the American Society for Mass Spectrometry. 1996;7(7):692–.

14. Yu W, Vath JE, Huberty MC, Martin SA. Identification of the facile gas-phase cleavage of the Asp-Pro and Asp-Xxx peptide bonds in matrix-assisted laser desorption time-of-flight mass spectrometry. Analytical Chemistry. 1993;65(21):3015–23.

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