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Index

Sr. No	Title	Author	Subject	Page. No.
1.	Assay Of Triphenylmethane Reductase Enzyme And PCR-Based Identification Of TMR Gene In Enterobacter Asbriae Strain XJUHX-4TM	Tina Mukherjee, Mounita Bhandari, Manas Das	Biotechnology	1-2
2.	An Analysis Of Growth Of Credit Card Industry	Dr. A. Vinayagamoorthy, K. Senthikumar	Commerce	3-5
3.	Impact Of Pre-Merger And Post Merger On Financial Performance (With Reference To Private Sector Banks)	Dr. Shital Vekariya	Commerce	6-8
4.	Relativity On Climate And Competencies In Human Resource Development With Reference To Neyveli Lignite Corporation Ltd,	S. Jayakumar. Dr. R. Ramachandran	Commerce	9-11
5.	Human Resource Outsourcing: A Strategy For Gaining Competitive Advantage	Dr. Santosh M. Singh	Commerce	12-13
6.	Relationship Between EVA And ROI And MVA (A Case Study Of Ten Manufacturing Industries In India)	Dr. Shivani Gupta	Commerce	14-15
7.	Modeling The Traits Of An Effective Teacher At Higher Education	Dr. Haridayal Sharma	Commerce	16-17
8.	Mahatma Gandhi National Rural Employment Guarantee Act (Mgnrega): Issues And Challenges	Dr. Mohd. Ashraf Ali, Mushtaq Ahmad	Commerce	18-20
9.	Standardisation And Grading	Viram. J. Vala, Dr. Vijay Kumar Soni	Commerce	21-22
10.	Profitability Of Selected Information Technology Companies In India	Dr. M. Jegadeeshwaran, C. Udaya	Commerce	23-25
11.	Emerging Trends In The Indian Media And Entertainment Industry	Dr Mahalaxmi Krishnan	Commerce	26-27
12.	Inventory Management Strategies And Control Techniques: An Empirical Investigation Of Small Scale Industries	Vipul Chalotra, Neetu Andotra	Commerce	28-30
13.	A Study On Performance Indicators Of Commercial Banks	Dr. G. Ganesan, P. Parthasarathy	Commerce	31-33
14.	Improved Approaches To Coreference Resolution In Machine Learning	Kuldeep Singh Raghuwanshi, Ashwini Kumar Verma	Computer Science	34-37
15.	Security Issues & Controls In Cloud Computing	V. Naga Lakshmi	Computer Science	38-40
16.	Human Development Index Of De-Notified Nomadic Castes In Maharashtra Division: A Study Of Jalna And Aurangabad Districts	Dr. Ashok Pawar	Economics	41-43
17.	Public Private Partnership In Rural & Urban Projects In India	Dr. Ashok S. Pawar, Dr. Shankar B. Ambhore	Economics	44-45
18.	Populace Insight On Development In Public Health Sector Of India Subsequent To Functioning Of National Rural Health Mission	Krishnakant Sharma	Economics	46-49
19.	Problems Of Rural Women Entrepreneurs In India: A Conceptual Overview	C. Jeyasri Usha N Devi, Dr. A. Sankaran	Economics	50-52
20.	Poverty Of Banjara And Vanjari Communities In India	Tidke Atish S., Dr. Pawar Ashok S.	Economics	53-54
21.	India And China: Economic Reforms And WTO	Dr. Surinder Kumar Singla, Dr. Kulwinder Singh	Economics	55- 56
22.	Implementing Life Skill Education Strategies In Teaching – Learning Process	R. Kalaiselvi, Dr. A. Palanisamy, Dr. A R. Saravanakumar	Education	57-59

23.	Utilisation Of Modern Technology By The Teachers In Pupil Processing Organisation	Dr. P.Paul Devanesan, Dr A. Selvan	Education	60-61
24.	Impact Of Vocational Training On Students	K.Sudha Rani, G.Umapathi, Dr. T. Ananda,	Education	62-63
25.	A Study On Emotional Intelligence Of Secondary School Teachers	Dr. Umme Kulsum, Prathima H.P.	Education	64-66
26.	The Efficiency Of Feedback Strategy Of Homework On The Development Of 10th Grade EFL Writing Skill In Al-Karak Educational Directorate	Majid Al- Khataybeh, Areej Al-Shourafa`	noitacudE	67-74
27.	Perspectives Of Stress Management In Education System	M. Meenakshisundaram, G. P. Raja, Dr. A R. Saravanakumar	Education	75-76
28.	Attention Regulation Of Meditators And Non-Meditators Of Class IX	G. Madhavi Kanakadurga, Dr. D. Vasanta Kumari,	Education	77-78
29.	Role Of Psychoeducation In Teaching – Learning Process	Dr. A R. Saravanakumar, Dr. A. Balu, Dr. S. Subbiah	Education	79-80
30.	Microcontroller Driven RGB Led System For Tristimulus Surface Colorimetry	T. N. Ghorude, A. D. Shaligram	Electronics	81-83
31.	Pmgsy And Rural Roads Development In India: Economic, Financial And Maintenance Issues	K.C. Manjunath	Engineering	84-86
32.	Routing Packets On A Chip.	Naren V Tikare	Engineering	87-89
33.	Finding The Nearest Neighbors In Biological Databases	Er. Pankaj Bhambri, Dr. O.P. Gupta, Er. Franky Goyal	Engineering	90-92
34.	Factors Affecting The Sustainability Of The Asphalt Roads: A Case Study Of Irbid Inner Ring Road, Jordan	Eng. Nasr Ahmad Dr. Mihai Iliescu	Engineering	93-94
35.	Physical And Chemical Testing Of Compounded PVC	Sapna Dabade, Dr. Dheeraj Mandloi, Deepak Khare	Engineering	95-96
36.	Impact Of Organic Farming On Yield Of Some Common Crops- A Case Study.	Namrata D. Awandekar	Environmental Science	97
37.	Hydrogeologic Settings Of The North And South Brahmaputra Plains In Upper Assam: A Comparative Study	Dr. Uttam Goswami	Geology	98-100
38.	To Study Staffing Pattern In Rajasthan Public Healthcare Delivery System.	Dr. Ashwin G. Modi, Sushman Sharma	Healthcare	101-105
39.	Work And Health: A Situational Analysis Of Factory Workers	Dr. S. S. Vijayanchali, Dr. E. Arumuga Gandhi	Home Science	106-108
40.	Performance Of Camel Kid Hair: Acrylic Blended Yarn And Knitted Fabric	Suman Pant, Anjali Sharma	Home Science	109-110
41.	Impact Of Holistic Nutrition Education Package On Diabetes Mellitus Control In Middle Aged Women	Dr. Anjali Rajwade	Home Science	111-112
42.	Assessment Of Relationship Between Ida And Personal Hygiene, Nutritional Knowledge And Dietary Practices In Adolescent Girls	Dr. Anjali Rajwade	Home Science	113-114
43.	Employee Attrition And Retention In Private Insurance Sector– A HRM Challenge	Dr. J. Senthil Vel Murugan, S.Bala Murugan	Human Resource Management	115-117
44.	A Study On Impact Of Unionism On Industrial Relations In Manufacturing Sector	Jaya Ahuja	Industrial Relations	118-120

45.	Augmentation Of India's Foreign Exchange Reserve: An Analysis	Dr.S P.Mathiraj, Ar.Annadurai	International Business	121-123
46.	Films – A Techno Literary Art Form	Dr. Dipti Mehta	Literature	124-125
47.	Indirect Models Of Reading To Develop Descriptive Writing	Dr. K. Madhavi	Literature	126-128
48.	Ramkrishna Mishra Ke Upanaso Me Rajnetaik Chetavni	Dr. Sanjay Rathod, Dilip Jhadav	Literature	129
49.	Hindi Kavita Me Nari Jivan Ka Badla Swarup	Dr. Sanjay Rathod	Literature	130
50.	Impact Of IPL Sponsorship On Consumer Buying Behavior With Reference To Nagpur City	Chandrima Das	Management	131-135
51.	Crowd Sourcing –A New Management Mantra	Devi Premnath, Dr. C. Nateson	Management	136-137
52.	Small Scale Industries In India: An Evaluation Of Productivity In The Post-Liberalized Scenario	Dr. Gaurav Lodha,	Management	138-139
53.	Comparative Analysis Of Milk Products With Respect To Its Competitors With Special Reference To Karnataka Milk Federation (KMF) – At Dharwada City, Karnataka, India	Dr. N. Ramanjaneyalu	Management	140-143
54.	A Study On Work Stress In Women Employees In Coimbatore District	R. Maheswari, N. Brindha	Management	144-145
55.	Accounting For Carbon Credits	Dr. Gaurav Lodha	Management	146-148
56.	A Literature Review On The Relationship Between Training (As A Core Responsibility Of HRM) And Firm Performance.	Priya Sharma, Dr. S. L. Gupta	Management	149-152
57.	A Study On Agricultural Marketing Practices And Constraints With Special Reference To Paddy / Rice.	CM Maran, Dr Raja Pranmalai	Management	153-156
58.	Performance Of Share Price Of Indian Public Sector Banks And Private Sector Banks - Comparative Study	V. Prabakaran, D. Lakshmi Prabha	Management	157-158
59.	Intuitionistic Fuzzy Primary And Semiprimary Ideal	Dr. M.Palanivelrajan, S.Nandakumar	Mathematics	159-160
60.	Significance Of Umbilical Artery Velocimetry In Perinatal Outcome Of Fetuses With Intrauterine Growth Retardation.	Dr G S Shekhawat	Medical Science	161-163
61.	Large Adult Sacrococcygeal Teratoma: A Case Report And Review Of Literature.	Dr.Yavalkar Pa, Dr. Naik Am.	Medical Science	164-165
62.	Epidural Steroid In Low Back Ache	Dr. B. L. Khajotia, Dr. Neelam Meena	Medical Science	166-167
63.	A Comparative Study Of Second Trimester MTP With Use Of Vaginal Misoprostol And Extra Amniotic Instillation Of Ethacridine Lactate.	Dr. Ketaki Junnare, Dr. Sameer Darawade, Dr. Priyamvada Shah, Dr. Swati Mali.	Medical Science	168-169
64.	A Novel Surgical Approach For Treatment Of Sui –TVT Obturator Tape	Dr. Ketaki Junnare, Dr. Durga Karne, Dr Neelesh Risbud.	Medical Science	170-171
65.	Advantage Of Fallopian Tube Sperm Perfusion Over Intra-Uterine Insemination When Used In Combination With Ovarian Stimulation For The Treatment Of Unexplained Infertility.	Dr G S Shekhawat, Dr Pushpalata Naphade	Medical Science	172-175

66.	"Bilateral Sertoli-Leydig Cell Tumor In Postmenopausal Female" A Case Report	Dr. Priyamvada Shah, Dr. Ketakijunnare, Dr. DurgaKarne	Medical Science	176-178
67.	Pretreatment With Ephedrine For Prevention Of Pain Associated With Propofol Injection.	Dr. Kavita U Adate, Dr. Jyoti A. Solanki	Medical Science	179-181
68.	Does The Structured Teaching Programme Influence The Knowledge About Physical Wellbeing Of School Children? A Quasi Experimental Study.	Dr. S. Valliammal, Dr. Ramachandra, Raja Sudhakar	Nursing	182-184
69.	An Approach For Information Retrieval For Bookstores Using Formal Ontology	Sumit Jain, C.S.Bhatia	Ontology	185-187
70.	Analgesic Activity Of Anacardium Occidentale	A. Devadoss, C. Aparna, K. Parimala, D. Sukumar	Organic Chemistry	188-190
71.	Behaviourism : Science Or Metaphysics	Dr. Jatinder Kumar Sharma	Philosophy	191-193
72.	Multi-Dimensional Perspectives Of Obesity And Its Management	S. Dhanaraj, Dr. A. Palanisamy	Physical Education	194-196
73.	Refractive Index, Density, Excess Molar Volume, Excess Molar Refraction For Liquid Mixtures (Ethyl Ethanoate + Benzene Derivatives) At Different Temperatures	Sheeraz Akbar, Mahendra Kumar	Physics	197-199
74.	Refractive Indices, Densities And Excess Properties For Liquid Mixtures (Cetane + Alkanols) At Different Temperatures	Sheeraz Akbar, Mahendra Kumar	Physics	200-202
75.	Capacity Building For Effective Local Governance: Indian Perspectives	Dr. Pralhad Chengte	Political Science	203-205
76.	Psychological Well-Being: A Study Of Non-Institutionalized Aged	Dr. Pankaj S. Suvera	Psychology	206-208
77.	Women Empowerment Through N R E G S (With Reference To State Of West Bengal)	Dilip Kumar Karak	Social Sciences	209-211
78.	Effect Of Selected Yogic, Aerobic And Laughter Exercises On Blood Pressure Of High School Boys	Dr.Manjappa.P, Dr.Shivarama Reddy. M	Sports	212-216
79.	Association Study Between Lead And Copper Accumulation At Different Physiological Systems Of Goat By Application Of Canonical Correlation And Canonical Correspondence Analyses	Partha Karmakar, Debasis Mazumdar, Seema Sarkar (Mondal), Sougata Karmakar	Statistics	217-219
80.	Development Of Silver -Silica Nanocomposite For Novel Humidity Sensing Application	Surender Duhan	Technology	220-221



Physical And Chemical Testing Of Compounded PVC

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ABSTRACT

PVC is a thermoplastic resin with a Glass Transition Temperature (T_g) of about 82°C [180°F] and a density of 1.38 g/cm^3 [86.15 lb/ft^3] that cannot be processed on its own due to its very low thermal stability and high melt viscosity. It is an amorphous linear molecule with small branches. Therefore, it is necessary to prepare an intermediate product where a variety of additives are mixed with the PVC resin to form a "dry-blend" that can be later melt-compounded or processed into a finished article. The unit operations present in the compounding of PVC involve delivering and storage of raw materials, feeding and spraying of all ingredients into a special mixer, mixing and heating the materials to create a dry-blend, then cooling and transferring the dry-blend to storage or to a conversion process such as molding, extrusion or calendaring. Moisture content of raw PVC, sulphated ash content, water absorption behavior has been studied because these are important features that determine end use applications of compound PVC.

Moisture analysis of Compounded PVC is carried in order to avoid splay marks on processing parts, loss on impact and loss of other properties.

The tendency of PVC to absorb water cannot be overlooked since even the slightest amount of water can significantly alter some key mechanical, electrical or optical property. The sulfated ash content test is carried out to indicate the level of known metal-containing additives or impurities in compounded PVC. Chemical resistant testing of sample prepared is also done using different chemicals.

Keywords : PVC, Testing

Introduction:

PVC is a prominent member of large family of plastic materials. PVC is a white granular thermoplastic material. The basic building block for PVC is 'vinyl chloride'. The PVC resulting from the polymerization process is not suitable for processing and must first be compounded to form a useful material. The PVC before compounding can be thought of as similar to flour, by adding various ingredients flour can be used to make for bread, cakes or many other items but on its own the flour is useless. In the similar manner PVC almost always requires conversion into a compound by the incorporation of additives such as heat stabilizers, UV stabilizers, lubricants, plasticizers, processing aids, impact modifiers, thermal modifiers, fillers, flame retardants, biocides, blowing agents and smoke suppressors, and, optionally pigments. Compounded PVC is useful because it resists two things that hate each other: fire and water. used to make raincoats and shower curtains, and of course, water pipes.

Methodology:

The compounding process is a first and crucial step prior to the production of any quality PVC end product. PVC resin would not be important in industry without their incorporation of

additives. Hence the importance of compounding additives in the successful production of quality products cannot be overstated.

Table 1: Additive and its Function:

Additives	Properties achieved
Anti-oxidants & other stabilizers	Slow down the rate at which the polymer will be degraded by oxygen, heat, visible light or UV radiation
Compatibilizers	Enable PVC to be mixed with other plastics and helps plastic recycling
Flame retardants	Reduce flammability of plastic
Pigments	To colour the plastic
Plasticisers	To produce flexible and manageable plastic
Impact modifiers	To absorb shock without damage
Fillers	Inexpensive, inert materials that simply add bulk to the plastic

Testing of PVC compound:

1. Sulphated ash content of raw PVC resin

Firstly we take a silica crucible and heat to redness for 10 minutes. Allow it to cool in desiccators and weight.

Transfer 1 gm of the substance to the crucible and Cool and moisten the residue with 1 ml of sulphuric acid, weight the crucible.

Then ignite gently at first, until the substance is through charred. Heat gently until the white fumes is no longer evolved and ignites at 800°C until all black particles have disappeared.

Conduct the ignition in a place protected from air currents. Allow the crucible to cool.

Add a few drops of sulphuric acid and heat. Ignite as before allow to cool and weight repeat the operation until two successive weighing do not differ.

2. Water absorption test

The tendency of PVC to absorb moisture cannot be overlooked since even the slightest amount of water can significantly alter some key mechanical, electrical or optical property. The test to determine the water absorption of PVC is as follows:

Firstly we take a silica crucible and heat to redness for 10 minutes. Allow it to cool in desiccators and weight.

Transfer the test specimen to the crucible and dried in a desiccators over calcium chloride for 24±1 hour. It is then weighed after its removal from the desiccators.

Specimen is then immersed in distilled water at 50±2°C for 48±1 hour.

After this, specimen is immersed in water at ambient temperature and cooled for 30±15 minutes, dried with filter paper and within 5 minutes, it is again reweighed.

3. Moisture analysis

The hygroscopic nature of PVC causes processing as well as dimensional stability problems. Moisture analysis of Compounded PVC is carried in order to avoid splay marks on processing parts, loss on impact and loss of other properties.

Procedure

Firstly we take a silica crucible and heat to redness for 10 minutes. Allow it to cool in desiccators and weight.

Transfer approximate 1 gm of the substance to the crucible.

Keep the crucible in an oven maintained at a temperature of 105±2°C for 1 hour.

The crucible is then removed from the oven and place in a desiccator for 30 minutes and allows to cool.

Calculation:

1. Sulphated ash content:

Formula Used:

$$\text{Sulphated Ash \%} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where

- W_1 = Constant weight of empty silica crucible
 W_2 = Weight of silica crucible with sample before heating
 W_3 = Weight of silica crucible with sample after heating
 $W_2 - W_1$ = Weight of sample initially taken
 $W_2 - W_3$ = Loss in weight after heating

2. Water absorption test:

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Formula Used:

$$\text{Water absorption \%} = \frac{W_3 - W_2}{W_2 - W_1} \times 100$$

Where

- W_1 = Constant weight of empty silica crucible
 W_2 = Weight of silica crucible with sample before immersion into water
 W_3 = Weight of silica crucible with sample after immersion into water
 $W_2 - W_1$ = Weight of sample initially taken
 $W_3 - W_2$ = Increase in wet due to water absorption

3. Moisture analysis:

Formula Used:

$$\% \text{ of moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where

- W_1 = Constant weight of empty silica crucible
 W_2 = Weight of silica crucible with sample before heating
 W_3 = Weight of silica crucible with sample after heating
 $W_2 - W_1$ = Weight of sample initially taken
 $W_2 - W_3$ = decrease in wet due to moisture

Results and Discussion:

- Sulphates Ash % = 0.08%
 Water Absorption % = 0.34%
 % of moisture = 0.13%

Table 3: Results of Immersion test

(+) Denotes resistance and () Not resistance

S. No.	Name of chemical	Observation	Result
1.	Hydrochloric acid-20%	No significant weight change	+
2.	Sulphuric acid -20%	No significant weight change	+
3.	Nitric Acid over-50%	Weight change	-
4.	Sodium Chloride	No significant weight change	+
5.	Glacial Acetic Acid	weight change	-
6.	Gasoline	No significant weight change	+
7.	Acetone	Dissolve	-
8.	Toluene	Dissolve	-
9.	Xylene	Dissolve	-
10.	Soap and detergents	No significant weight change	+

Conclusion

The data sheds light on the performance of the materials in water or humid environments.

These results show that Compound PVC prepared in this study can be used for water piping, Waste water pipes, grating covers, guttering, drain pipes, waste water fittings, roofing sheets etc. since the water absorption material is considerably lower.

Compound PVC is highly resistant to attack of inorganic acids, alkalies and many organic acids. Exceptions are hot nitric acid of concentration above 50%, highly concentrated oxidizing acids. Attack consists of the surface rather than penetration hence can be used for oil and beverage bottles.



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