



**INDIAN RESINS MANUFACTURERS' ASSOCIATION**

# **eNewsLetter**

## **Edition: October 2022**

**INDIAN RESINS MANUFACTURER'S ASSOCIATION (IRMA)**

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# IRMA eNewsletter

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Published by

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**INDIAN RESINS MANUFACTURERS' ASSOCIATION**

## From The Editor's Desk



Dear Friends,

I am glad to inform you that this is the second edition of Irma e-Newsletter published under my editorship which will be of interest to you.

With all of your support and contribution I will make every effort to bring the magazine regularly with good and useful reading material. You are most welcome to give your suggestions to further upgrade IRMA e-Newsletter. We also request you all to give us articles on technical, commercial or any other subject of educate value to our members.

The industry scenario is encouraging and entering into growth and profitable stage with good rains even though there is overall increase in raw material cost.

IRMA had organised a Workshop known as "Azelis-Irma Knowledge sharing Workshop" on 29th of July 2022 for the benefit of all Members (i.e. resin/coating/chemical industry members). We thank all members who had whole-heartedly supported and participated in this event.

We at IRMA are planning to organise Seminar in the month of February 2023 and we wish all of you should attend and enrich the knowledge. It will be a pleasure-cum-educational Seminar outside Mumbai. We will communicate the details shortly.

HAPPY READING !

N. Kannan  
Chief Editor

## From The President's Desk



**S. Mahadevan**  
President

Festive greetings to All members of the IRMA Family.

I take this privilege to address all you members in the 2nd edition of IRMA *e-newsletter* which is edited by our Executive Secretary and Chief Editor, Shri Kannan. I also take pleasure to extend Diwali and New Year greetings to all of you.

With industrial activities gathering momentum, the past couple of months have been buoyant for industries at large. With the Covid fears receding and Global crude showing signs of stabilizing, we expect good growth across all industries going forward. With a bountiful Monsoon and festive fervor gripping the country, the Indian growth story is poised for its highest growth.

We at IRMA not to be behind were active too with activities for our members. The Azelis-IRMA joint workshop conducted at the Azelis office was a novel idea for knowledge sharing and was well attended by members. This was followed by a visit to Azelis Case Lab and networking lunch. IRMA AGM was held in September at Chembur Gymkhana which saw a good gathering by the industry at large. The highlight was a lecture on “Energy Price Risk Management” by Mr. Ashish Bhagtani followed by a motivational lecture on Samudra Manthan by Mr. Rajesh Kamat.

Going forward IRMA is pleased to announce its Residential Seminar under the convenorship of Shri Challawalla in mid February 2023 at Silvasa. We request members to strengthen our efforts by planning in advance and attending in huge numbers.

Once again on behalf of my team, I would like to extend my Greetings to all Members and their families.

Thank You.

S. Mahadevan  
President

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# STYRENE FREE THERMOSETS: The battle against VOC

Devesh Sane<sup>A</sup>, Sanyog Raut<sup>B</sup>

Institute of Chemical Technology<sup>A</sup>, Patkar-Varde College<sup>B</sup>

## ABSTRACT

Thermosets have attracted a lot of attention and technical advancement in recent decades. Due to their adaptability, thermosets with an unsaturated double bond curing mechanism are of particular concern. Reactive diluents (RDs) containing unsaturated sites are typically added to such resins to increase their processability and mechanical qualities. As styrene is the typical RD employed in the sector, toxicity and VOC issues also occur with its exploitation. The purpose of this article is to review the advancements made in styrene replacement in thermosets. Potential styrene substitutes are briefly examined, including vinyl derivatives of benzene, (methyl)acrylates, and biobased substitutes.

**Keywords:** thermosetting resin; styrene-free; reactive diluent; Low VOC; biobased

## Introduction

The fast-paced growth of the polymer industry has driven a wider utilization of thermoset resins cured from unsaturated sites, i.e. Unsaturated Polyester Resin (UPR) and Vinyl esters.<sup>[1]</sup> Mostly these materials are prepared from a condensation reaction between saturated diol and an unsaturated diacid. The unsaturation or double bond formed undergoes free radical polymerization which in turn cures or crosslinks the resin. The UPR obtained is solid at room temperature which makes its use in further applications difficult so a reactive diluent (RD) needs to be added to the resin for easy processing. The main difference between a solvent and reactive diluent is that during crosslinking the solvent evaporates but the reactive diluent reacts and forms an integral part of the coating.<sup>[2]</sup> These resins approximately contain 30-35% of this reactive diluent.

In today's industrial practice, Styrene is a conventional and preferred RD at the moment and offers benefits like inexpensive cost, low molecular weight, strong reactivity, and great polymerizability.<sup>[3]</sup> The high vapor pressure and low boiling point of styrene make it a volatile organic compound (VOC) on top of that the National Institute of Health of USA listed it as a potential carcinogen in 2011 and hence increasing its risk to humans and the environment. This article aims to briefly summarize the different chemistries which have been developed and can replace styrene as reactive diluents in thermosets.

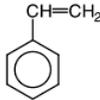
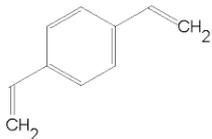
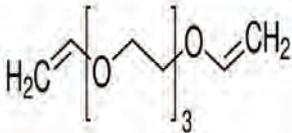
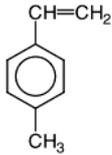
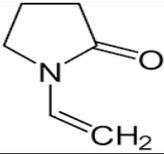
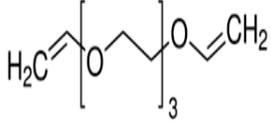
## Vinyl Monomers

Divinylbenzene (DVB), a benzene derivative, is structurally similar to styrene and has been explored extensively as a possible replacement for styrene since the early 20th century. DVB has a low molecular weight, two unsaturated double bonds, and a high degree of reactivity. However, due to its high reactivity, DVB may rapidly undergo self-polymerization and is difficult to mix with resins, forming white particles. Additionally, it is unclear how hazardous the crosslinking agent DVB is. More recently, styrene was replaced

by two new kinds of vinyl monomers, namely N-Vinyl-2-pyrrolidone (NVP) and tri(Ethylene-glycol)divinyl ether (TDE), in UPE resins for the manufacturing of hemp fiber reinforced composites. Due to nitrogen's strong electronegativity, the C=C bond that binds it to NVP has a high degree of reactivity. There are additional options for crosslinking with UPE since TDE has two C=C bonds.<sup>[5]</sup>

As an alternative to styrene, several vinyl and divinyl ethers have been tried. The usage of divinyl ethers with unsaturated polyesters is preferred in compositions and coatings that are radiation curable.<sup>[6]</sup> However, there are unique formulas that may be utilized for gel coatings instead of styrene and instead comprise triethylene glycol divinyl ether. Propenyl ethers often require less preparation than their equivalent vinyl ethers. The equivalent allyl ethers are simply isomerized to create the propenyl ethers. The propenyl ether molecules are anticipated to be significantly less reactive than their vinyl ether analogues because of the steric influence of the methyl groups. Ethoxylated hexanediol dipropenyl ether and 1,1,1-trimethylol propane dipropenyl ether are two examples of propenyl ethers.<sup>[7]</sup>

**Table 1: Vinyl monomers as Reactive diluents (Data obtained from [www.sigmaaldrich.com](http://www.sigmaaldrich.com))[13]**

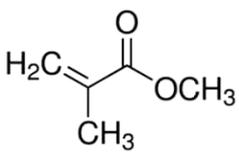
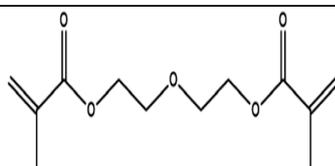
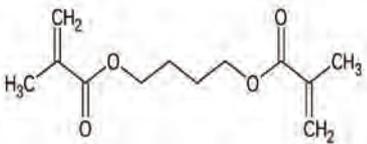
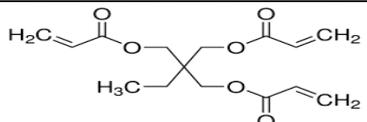
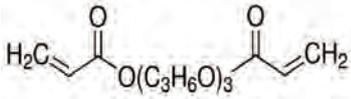
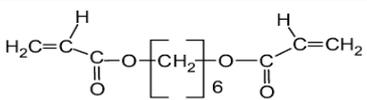
Monomers	Mol Wt.	Boiling Point	Toxicity	Chemical Structure
Styrene	104.15	145 °C	Irritation of the mucous membranes of the nose and throat, increased nasal secretion, wheezing and coughing	
Divinylbenzene	130.19	195°C	Skin and eye irritation, Eye damage, dizziness, lightheadedness	
Tri (Ethylene-glycol) divinyl ether (TDE)	202.25	126°C	-	
Vinyl toluene	236.4	175°C	Neurotoxic	
N-Vinyl-2-pyrrolidone (NVP)	111.14	95°C	-	
Triethylene glycol divinyl ether	202.25	126°C	Allergic reaction, respiratory irritation	

## Acrylate

Common sources of acrylate monomers are nonrenewable ones. They often feature very reactive C=C bonds and small molecular weight. A lot of products, including coatings, elastomers, adhesives, thickeners, amphoteric surfactants, fibers, plastics, textiles, and inks, have been made using acrylates.<sup>[1]</sup> The diluents for the polyester modified with acrylic are quite compatible with other film-forming polymers. Additionally, the comonomers of acrylate are in charge of regulating the thermal shrinkage of UPR<sup>[6]</sup>. UPR modified with acrylic is preferred over UPR with styrene because it is more reactive and volatile. For instance, diethylene glycol dimethacrylate (DEGDMA) and butanediol dimethacrylate (BDDMA) is less volatile than styrene and methyl methacrylate (MMA), which evaporate in less than an hour.

Variations in characteristics may be possible depending on the acrylate used. For instance, the multifunctional monomer TMPTA may effectively increase the crosslinking density of an epoxy acrylate system; in contrast, TPGDA and HDDA have a linear structure and can therefore increase the system's elasticity<sup>[9]</sup>. Because of their strong elasticity and impact strength, a number of polyol-based reactive diluents might be thought of as a possible option to increase the resistance of epoxy resin against brittle fracture.

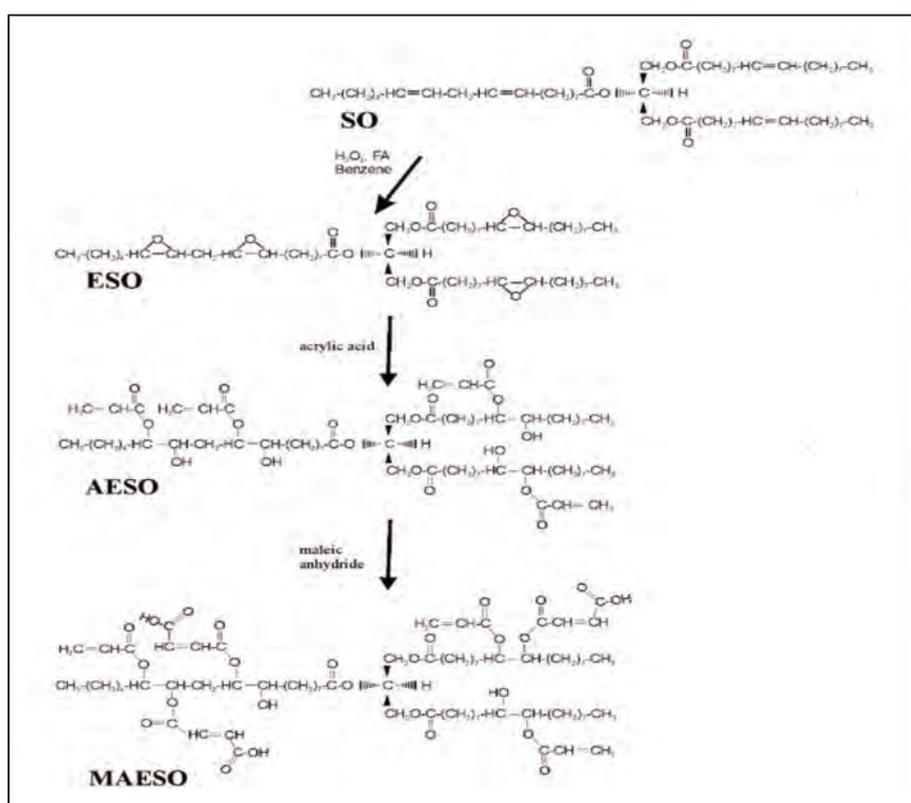
**Table2: Acrylate monomers as reactive diluents (Data obtained from www.sigmaaldrich.com)<sup>[13]</sup>**

Monomers	Mol Wt.	Boiling Point	Toxicity	Chemical Structure
Methylmethacrylate (MMA)	100.121	101°C	Hypersensitivity, asthmatic reactions, local neurological symptoms, irritations and local dermatological reactions.	
Diethylene glycol dimethacrylate (DEGDMA)	242.27	134°C	Allergic reaction, respiratory irritation	
Butanediol dimethacrylate (BDDMA)	226.3	134°C	Respiratory irritation	
Trimethylolpropane triacrylate (TMPTA)	296.31	380°C	-	
Tripropylene glycol diacrylate (TPGDA)	300.348	122°C	Skin and Eye irritation, Respiratory irritation	
1,6 Hexanediol diacrylate (HDDA)	452.5	165°C	Skin and respiratory irritation	

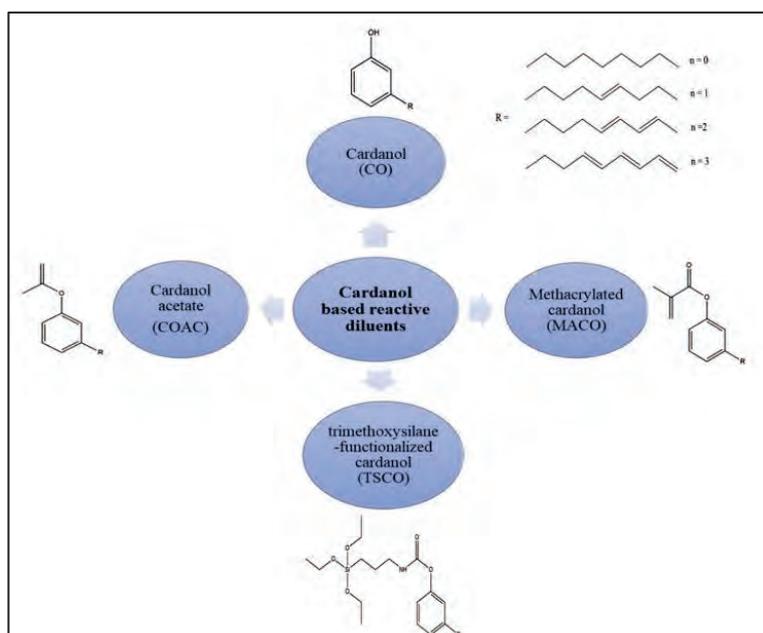
## Biobased RD for thermosets

To create new cross-linkable polymers, renewable resources have been extensively researched. Typically, 35–50% of reactive diluents with a petroleum basis are included in thermoset resins. The development of bio-based polymeric materials from renewable natural resources, such as proteins, carbohydrates, lignin, and vegetable oils, to mention a few, is, nevertheless, urgently required due to growing environmental concerns and the depletion of nonrenewable petroleum resources. Among these, vegetable oils (such as soybean, corn, tung, linseed, cottonseed, palm, peanut, rapeseed, sunflower, safflower, coconut, and castor) are attractive building blocks for creating bio-based thermosets due to their widespread availability, sustainability, affordable price, and low toxicity.<sup>[3]</sup>

Soybean oil contains more than 99% triglycerides formed by one glycerol attached to three fatty acids. Most of the native carbon-carbon double bonds in soybean oil are non-conjugated. Epoxidized soybean oil (ESO), acrylated epoxidized soybean oil (AESO), and maleinated acrylated epoxidized soybean oil (MAESO) are only a few examples of the many methods that have been used to create soybean oil-based thermosetting resins.<sup>[10]</sup> Cardanol occurring in the cashew nutshell liquid (CNSL) is phenolic in nature and has been modified into several RDs namely Cardanol acetate, Methacrylated cardanol, Trimethoxysilane functionalized cardanol, and many more.<sup>[11]</sup> The addition of acrylated cardanol significantly improved the resins' T<sub>g</sub>, thermal stability, hardness, and hydrophobicity (AC). As a result, AC may be used to create biobased coatings with unique qualities including high biobased content and low shrinkage by substituting for petroleum-based monomers.<sup>[12]</sup> Many more raw materials and their modification are available but all cannot be covered in this single article.



Soya oil reactive diluents [10]



Cardanol-based reactive diluents [11]

## Conclusion

Alternatives must be found for petroleum-based solvents given the VOC they produce. Numerous petroleum-based monomers might be readily commercialized in thermosets and their composites as direct styrene substitutes. The synthesis of RDs from renewable resources is a subject that is getting more and more intriguing. The following are their benefits: They reduce the usage of fossil fuels: (1) the raw ingredients are renewable; (2) new polymers with enhanced characteristics are generated; (3) they can replace styrene and lower VOC emissions. There have been some improvements achieved recently in the production of biobased reactive diluents with wide-ranging characteristics, although this area has not yet been fully explored. It is essential to advance the commercialization of these bio-based reactive diluents.

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## AZELIS-IRMA knowledge sharing workshop

INDIAN Resins Manufacturers' Association (IRMA) had conducted a half day Workshop jointly with Azelis (India) Pvt.Ltd., a member of IRMA, at Azelis (India) Pvt.Ltd., at their Navi Mumbai office on 29th July 2022. It was known as "AZELIS-IRMA Knowledge Sharing Workshop" to explore infinite opportunities in Resins and Allied Coating industry. More than 50 delegates attended this event.

The inauguration was done by Ms. Aparna Khurana, Managing Director of Azelis (India) Ltd., along with Mr. S. Mahadevan, President of IRMA and the Guest of Honour



L to R: Aparna Khurana, Samir Rawal, RMS Sandhu and S. Mahadevan



S. Mahadevan

- Mr. Samir Rawal, Regional Business Director – India, China & ASEAN, Indorama Ventures Oxides Ankleshwar Pvt Ltd and Mr. RMS Sandhu, Regional Segment Leader South Asia – CAS & Industrial Silanes, Momentive Performance Materials (India) Pvt. Ltd, in the presence of dignitaries, IRMA Managing Committee and delegates.



Ms. Aparna Khurana

There were three technical lectures and exclusive tour of Azelis CASE Lab in

India. The Coordinator of this workshop was Dr. Parag Raut of Azelis (India) Pvt.Ltd and committee member of IRMA. The first lecture/presentation was given by Mr. Ankush Panchagade, Technical Service Manager – CAS (India, Middle East, Africa & SEA) Momentive Performance Materials (India) Pvt.Ltd., on the subject "Solutions for paints and coatings".



Dr. Parag Raut



Hiren Shah



Second lecture was given by Mr.Ketan Dave, DGM, Grand Polycoats Co. Pvt.Ltd on the subject "Trends in resin technology"and third one by Ms. Shraddha Kadage (Sr. Application Scientist from Indorama Ventures) on the subject "Surfactants for coatings". Introduction of Azelis (India) Pvt. Ltd. was done by Dr. Parag Raut. Mr.Hiren Shah gave the vote of thanks.



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## EVENTS

### **Irma Annual General Meeting held on 23rd September 2022 at The Chembur Gymkhana, Phase-I Basement Hall, Chembur, Mumbai - 400071**

The programme started at 7.00 P.M. Irma President, Mr. S. Mahadevan gave a brief welcome speech highlighting the activities held during the year and also spelled about the future activities especially about the forth coming Seminar scheduled to be held in the month of February 2023 outside Mumbai. He said the details about the Seminar will be intimated to all in due course of time. Members totalling about 60 Nos. attended this event.

Thereafter the IRMA AGM proceedings carried out by Hon. Secretary, Mr. Aditya Chandrachud. The vote of thanks given by Vice President, Mr. Hiren Shah.

There was presentation by Mr. Ashish Bhagtani, Senior Manager – PMT Energy of M/s. MCX India Ltd., as an “Awareness Partner” and spoke on the subject “Energy Price Risk Management”. It was well received by Irma members.

Second lecture/presentation was done by Mr. Rajesh Kamath, an Electronic Engineer, an MBA in HR, a Consultant, Coach, Teacher, Author and speaker wherein the objective is to apply principles of Kautilya's Arthshastra and other eternal texts to modern organisation combining West and Indian Management Sciences. The members present appreciated this lecture too.

Vote of thanks given by Mr. Ashay Mehta, Committee Member followed by networking and dinner.





## RAW MATERIAL SCENARIO

**Rates are per KG for bulk buying. Rates prevailing as on 14th October 2022**

Phthalic anhydride	...	Rs.110-112
Pentaerythritol	...	Rs.135-140
Glycerin	...	Rs.80-84
Rosin Indonesia	...	Rs.122-124
Cyclohexanone	...	Rs.132 (Ex Kandla)
Fatty Acid	...	Rs.100-102
Ethyl. Acetate	...	Rs.90-95
Slop and mix Xylene	...	Rs.89/kg & 102/Kg (Reliance)
Castrol	...	Rs.142-143 (on downward trend)

*- Compiled by M.N. Challawala*

# JOKES



Two engineers, were standing at the base of a flagpole, looking up. A woman walked by and asked what they were doing. 'We're supposed to find the height of the flagpole', said one, 'But we don't have a ladder!' The woman said, 'Hand me that wrench out of your toolbox!' She loosened a few bolts, then laid the pole down. She then took measuring tape from their toolbox, took the measurement and announced, 'Eighteen feet, six inches' and walked away. The second engineer shook his head and laughed and said. 'We need the height and she gave us the length!' Both the engineers are still finding a job



## Smart Hosts

It was at a party and the host was getting worried because there were too many people and not enough refreshments. She was sure that not all of these people had been invited but didn't know how to tell which ones were the crashers. Then her husband got an idea... He turned to the crowd of guests and said "Will those who are from the brides side of the family stand up please?" about twenty people stood. Then he asked " Will those who are from the groom side of the family stand up as well?" about twenty five people stood up. The He smiled and said

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"Will all those who stood please leave, This is a birthday party".



## Wants to get married!!

"Honey," said this husband to his wife, "I invited a friend home for supper."  
"What? Are you crazy? The house is a mess, I didn't go shopping, all the dishes are dirty, and I don't feel like cooking a fancy meal!"  
"I know all that."  
"Then why did you invite a friend for supper?"  
"Because the poor guy is thinking about getting married."



Customer: "How much for haircut?"  
Barber: "20 Rupees."  
Customer: "How much for a Shave?"  
Barber: "Ten rupees."  
Customer: "Great-shave my head, please!"

