Icynene:

More than 25 years of safe and proven performance

ICYNENE®
The Evolution of Insulation

Our History

Established in 1986, Icynene was founded to commercialise a new low density spray foam technology for the building construction sector. The company's core innovation was a new, low density spray foam shipped to job sites in a compact, two-component format for use in fixed-proportion, lorry-mounted, spray rigs. Rapidly expanding 100 times its original volume, the product provides both insulation and an air barrier - key components of energy efficient construction.

The innovation was significant in that Icynene 'Gold Seal', as it was called then, used water as the blowing agent and was not formaldehyde based (i.e. urea-formaldehyde foam) and contained:

- No CFCs or HCFCs
- No PBDEs
- Low VOCs

To reach the market, Icynene Gold Seal was extensively studied for insulation and air barrier performance, product stability and product safety by industry-recognised evaluation services around the world. After more than 25 years, successful installation in more 350,000 homes and product development have helped prove the effectiveness and safety of this innovation.

Icynene has gone on to expand its product line to include a range of medium density, as well as innovative low density, spray foams. At the core, however, is extensive product research and a commitment to quality.

Global Recognition

Icynene spray foam products have gained recognition and approvals from the following organisations based on product performance and low VOC emissions.

ISO 9001:2008 Recognised & Certified

Icynene's plant and manufacturing processes are ISO 9001:2008 registered and certified. Icynene products have been extensively tested and Icynene's plant is regularly inspected for adherence to strict manufacturing and quality control processes by:

- Intertek Testing Services
- Exova Laboratories
- QAI Laboratories

with the result that these products are well known and understood.

In terms of product safety, comprehensive testing and research has proven that:

- Icynene reagents begin to react within seconds and are fully cured within 2 hours.
- Volatile organic compounds (composed of amines that control the reaction and trace levels of other gases) dissipate such that indoor air quality returns to its previous condition in 12* to 24 hours and contributions from Icynene foam reactions become undetectable within 30 days.
- Reviews by independent toxicologists have determined that the recommended 24 hour exclusion period for buildings insulated with Icynene is protective for residents.

Icynene is possibly the most extensively-studied family of spray insulation products in North America and Europe and the research continues to expand what is known about how exceptionally well Icynene products perform.

* On-site contractors and workers may return to the job site in 12 hours provided that increased ventilation is maintained (min 1.0 ACH) when any worker is present. Adjacent spaces do not have to be vacated provided adequate exhaust ventilation is provided In the work area.

Our Dealer Network

A key aspect of delivering high quality insulation and air barrier spray foam products is the Icynene dealer.

- Icynene pioneered the concept of dealer training and its training of sprayers and helpers remains as one of the most extensive resources available to site personnel in the spray foam industry.
- Icynene does **not** sell its products to non-licensed dealers, or to Do-it-Yourselfers, or through third-party distributors.

This allows Icynene Dealers to offer a Limited Lifetime Warranty on all Icynene spray foam products. It also provides protection helping to ensure that products are properly applied by applicators who understand the product and can optimise performance.

Icynene is also working through organisations such as the American Chemistry Council Center for the Polyurethanes Industry and the Spray Polyurethane Foam Alliance to expand its training and to help ensure that Health and Safety is a core focus of all worker activities on site. This effort is helping to standardise training for spray foam crews and it includes:

- ACC-CPI developed Health and Safety training for installers and helpers
- SPFA training for Insulation:
  - Installers
  - Master Installers and
  - Project Managers

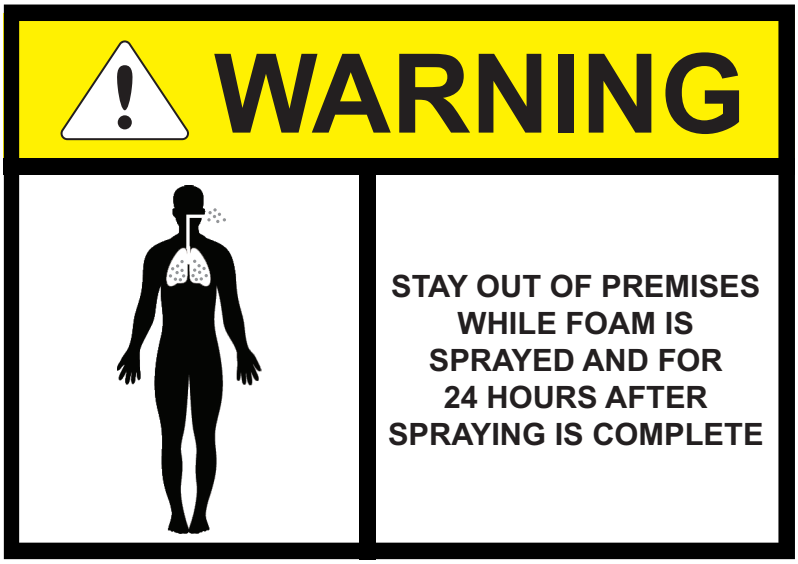
Installation Equipment & Worker Safety

Icynene believes that whole building insulating and air sealing is best accomplished by using lorry-based spray rigs. The rigs are typically equipped with:

- Independent power supply / generation systems to supply adequate power without need to tamper with or modify site systems
- Fixed-volume proportioning systems that supply A-side and B-side chemicals in a balanced 1:1 fixed ratio
- Supplied air respirator air pumps for independent supply of fresh air to installers and helpers
- Personal Protective Equipment (PPE) for workers including full body coveralls, gloves, Supplied Air Respirator (SAR) masks and other equipment to safely install/trim spray foam

Combined with tarps, temporary ventilation fans, and other preparation of the site, these systems and equipment provide a means of safely, quickly and consistently delivering high performance insulation and air barrier systems in increasingly complex architectural designs.

Installation in Occupied Buildings



Icynene installation protocols require that building occupants stay away from the premises during spraying and for 24 hours after spraying is complete. Icynene also requires that spray foam activities be separated from living spaces by at least 50 feet and/or by physical barriers that could include partitions, tarps, temporary air sealing measures, etc. Appropriately supervised on-site contractors and workers informed about the SPF application may re-enter the work area provided increased ventilation is supplied during spray and maintained immediately thereafter as recommended in the table to the right. Adjacent spaces need not be vacated provided adequate exhaust ventilation is provided in the work area and exhaust air does not recirculate to the adjacent space.

When combined with adequate exhaust ventilation, these measures help to confine spray mist, particles, dust and fumes to the work area and avoid exposure for persons not involved in the application of insulation materials. This also helps to ready the space for re-occupancy after spraying.

The measures are similar to those which should be employed for spray painting, grinding or any activity that generates spray vapors and/or dust particles. With regard to occupational exposures, studies have shown that in less than 24 hours, Volatile Organic Compounds (VOCs) and other trace contaminants in the work area are well within standards established by OSHA, NIOSH and other authorities.

Also, with regard to residents re-occupying the building after 24 hours, the toxicological review determined that full re-occupancy would be permitted.Taken together, the studies and review indicate that, within 24 hours, a workspace sprayed with Icynene spray foam meets worker safety standards and the living space is ready for re-occupancy by residents.

Equipment Safety & Performance

One of the areas where spray foam technology is continuing to improve is in the area of equipment performance and safety. Today's proportioning systems are designed to deliver a finer spray mist and allow the installer to closely monitor quantities of raw materials consumed, application temperatures and pressures, as well as many other performance indicators. This improves the cell structure and material quality.

Just as fuel injection greatly improved the performance of automobiles, digital controls and automated shut-offs have helped improve the performance of spray foam proportioning systems. Today's systems are equipped with automated shut offs that sense flow restrictions, clogging of filters and other conditions that could lead to off-ratio (i.e. not 1:1 ratio) metering of chemicals. This control system stops the spray process when off-ratio mixing starts at the equipment, preventing any significant amount of potentially off-ratio foam from being applied.

This helps installers because spraying off-ratio decreases productivity, costs money, and degrades the visual appearance and quality of the finished product.

Above: Graco Reactor E-30

Product Formulation

Icynene spray foam is formed when two components are mixed: A-side (ISO) and B-Side (Resin). The two components react and give off carbon dioxide and heat which expands the blowing agent and/or water (as steam) to create tiny bubbles in the plastic matrix.

The A-Side (ISO) typically contains a mix of methylene diphenyl diisocyanate (MDI) and/or polymeric MDI (pMDI). These are smaller chemical compounds with bonding sites that allow them to link to form into a three dimensional network of long polymer chains that form the backbone of the cellular plastic.

The B-Side (Resin) is a proprietary mix that typically contains:

- Polyols - oils and oil derivatives that bond to the MDI to create polymer plastic
- Flame retardants - additives that enhance its fire resistance properties
- Water and/or blowing agents - components that expand the plastic into foam
- Catalysts - agents that control the rate of reaction
- Surfactants - components that control the mixing of raw materials

Chemical Components & Health

As with most consumer products, many people would like more information about the raw materials in spray foam. As previously indicated, polyurethane foams generally, and Icynene specifically, have been studied extensively in conjunction with documenting the improvements compared to earlier spray foam products. The following information summarises the findings of much of this research.

MDI

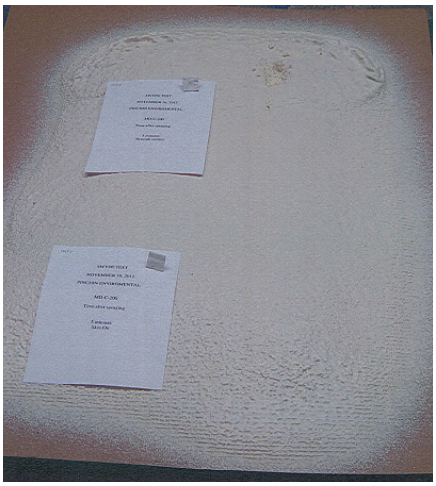
MDI and pMDI react quickly and aggressively not only with polyols but also water, water vapour, and natural oils. This characteristic is the basis for ensuring that worker protection protocols are followed, as MDI/pMDI reactions can affect skin or the respiratory passages when inhaled. But this same characteristic also means that reactive forms are short-lived, which is the basis for rapid dissipation of forms that could affect residents.

Recent testing suggests that MDI is typically not found on uncut and cut surfaces of spray foam in as little as five (5) minutes after spray. Other testing of air samples suggests that it cannot be detected approximately two (2) hours after spray.

Proper use of personal protective equipment during and immediately after spray application should be sufficient to prevent contact with MDI.

POLYOLS

Polyols and natural oils used in spray foam formulations such as soya oil and castor oil are generally accepted as safe and not a health concern. Some are even considered foodstuffs.



Left: Swipes indicator strips did not change colour indicating MDI was fully reacted less than 5 minutes after spray.

FLAME RETARDANTS

The use of flame retardants in foam is mandated by fire protection codes. Spray foam must have a maximum Flame Spread Index of 75 and a maximum Smoke Developed Index of 450 when tested to ASTM E84 / UL 723. Flame retardants are needed to achieve this result in spray foam.

Icynene generally uses TCPP as the flame retardant of choice in its foams. Icynene products do not contain PBDEs or TCDPP.

BLOWING AGENTS/WATER

Blowing agents have many uses that include various cleaning functions in laboratories and hospitals. The off-gassing of blowing agent from spray foam is typically not significant once the foam cells have formed. Cell formation is aimed at containing blowing agents. Blowing agent molecules tend to be larger and more easily contained in the foam matrix. As with other constituents, studies indicate that within 24 hours of spraying, blowing agent releases in rooms that have been insulated with spray foam have dissipated such that air quality returns to previous conditions.

Chemical Components & Health

CATALYSTS

Although amine catalysts are used in combinations to speed up/slow down the foam reaction they typically make up less than 5% of the finished foam. They control the speed of reaction such that foam formation occurs at a rate that will optimise cell structure and physical characteristics particular to the formulation.

During spray, and for a short time thereafter, the catalysts can be released from the foam. Studies indicate that, over the next thirty days, they will decrease to the point where their concentration is not measurable.

Catalysts can have a unique odour that can be detected by people who are particularly sensitive to and notice their smell. Typical thresholds for smelling catalysts are in the “parts per billion” (ppb) range. Recognising this odour is not, however, an indication of concern for other effects since the odour detection threshold is many times (typically thousands of times) lower than concentrations needed to produce other effects.

Some catalysts are associated with a temporary condition referred to as “blue haze”. Icynene does not use these raw materials in its product formulations.

None of the raw ingredients Icynene uses in formulating its foam systems appear on California’s Proposition 65 hazard list.

OFF-GASSING FROM FINISHED FOAM

The guidance given to Icynene Spray Foam Dealers is that buildings newly insulated with Icynene Spray Foam are ready for re-occupancy in 24 hours. jobsite workers (other contractors etc) may return to the work area in 12 hours provided increased ventilation is maintained (min 1.0 ACH) while workers are present. Adjacent spaces do not have to be vacated provided adequate exhaust ventilation is provided In the work area.

Saskatchewan Research Council (SRC) Studies

This recommendation/analysis is based on several SRC studies showing that once spray application of Icynene Spray Foam is complete, under modest ventilation rates of 0.3 air changes per hour (ACH), levels of volatiles dissipate within 24 hours. The analysis was produced and reviewed by independent toxicologists who determined that buildings insulated with Icynene were suitable for re-occupancy within 24 hours.

The research determined that the off-gassing consisted primarily of amine catalysts and traces of other gases that were present in minute quantities in the raw materials.

These releases were all within acceptable levels per the research council within 24 hours. Over a period of 30 days the off-gassing decreased to levels not detectable by the measurement apparatus.

Toxicologist Dr. Lalita Bharadwaj, Ph.D. reviewed that data on one Icynene product sold currently in Europe:

- H_2Foam LIte (LD-C-50)

Dr. Bharadwaj determined that buildings insulated with these Icynene products would be safe for re-occupancy in 24 hours after spraying is complete.

Icynene is working with federal agencies and other industry partners to find ways to shorten the re-occupancy period (e.g. through higher rates of ventilation, etc.) In the interim, 0.3 ACH for 24 hours has been proven and independently verified for safety.

Study of Icynene H_2Foam Lite (LD-C-50) Spray Foam Insulation Performed by Saskatchewan Research Council Report 1-4801-9-C-94

Compound Detected	Proprietary amine [ppm]	2-pentanal, 2 methyl [ppm]	Chlorobenzene [ppm]	Proprietary amine [ppm]	Phenol 2, 6-bis (1.1-dimethylethyl) 4-methyl [ppm]
Detection limit	0.0016	0.00014	0.0013	0.00054	0.00033
1 hour	0.27	0.03	0.05	N	N
12 hours	0.26	0.012	0.008	N	N
1 day	0.02	N	N	N	N
2 days	N	N	N	0.08	N
4 days	N	N	N	0.08	0.01
7 days	N	N	N	0.06	0.008
14 days	N	N	N	0.009	N
30 days	N	N	N	N	N

Note: N= none detected / below detection limit.

Collaborative for High Performance Schools

Most products that Icynene sells in the U.S. have been tested to gain certification with the Collaborative for High Performance Schools to CHPS 13050.

The procedure uses data from samples of foam conditioned for 96 hours to model room concentrations for classrooms and offices and compares that result to stringent standards set in place for contaminants such as formaldehyde and VOCs.

In the most recent round of testing, to the latest standards, all Icynene Spray Foams tested were able to gain certification for complying with the requirements for **both** schools and offices (more confined spaces).

COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS MEMBER

Summary of testing of Icynene Spray Foam Products to determine conformance to criteria set by the Collaborative for High Performance Schools. Off Gassing at 96 hrs using CHPS 01350 Criteria. Data collected by Berkeley Analytical Associates LLC.

Product Name	Off-gas Item Identified	Classroom Conc. [ug/m³]	Office Conc. [ug/m³]	cREL Limit* [ug/m³]
H2Foam Lite (LD-C-50)	Formaldehyde	4.5	5.2	9
	Propaneitrile, 3-(dimethylamino)	3.5	4	N
H2Foam Forte	1,4-Dioxane	3.6	4.1	3000
	Propeylene Carbonate	3.6	4.1	N
	2,2- Difluoropropane	154.4	177.7	N

Note: * N = No Limit Listed

MDI/pMDI Off Gassing

Numerous air quality tests in buildings insulated with Icynene show that raw reactive ingredients like MDI and polyols react very quickly and do not appear as off-gassing compounds from finished foam.

Tight Buildings & Ventilation

Icynene Spray Foam can greatly increase the air tightness of a building. The result can be slower elimination of volatiles from other materials in the building. Some people have questioned the wisdom of tightening buildings if this is the result.

But air leaky buildings have problems too, including poor humidity control, concealed condensation, mold, mildew, corrosion and rotting.

Sound Building Science suggests that air-tightened buildings should be coupled with continuous mechanical ventilation for maximum control of humidity and pollutants. References such as ASHRAE 62.1 and ASHRAE 62.2 can be used for sizing of ventilation equipment.

Off Ratio Foam

There is speculation in some quarters that "off-ratio" spray foam might be the basis for complaints by building occupants. While it is theoretically possible to create scenarios where off-ratio foam is produced, several key factors contribute to show that, in practice, off-ratio foam is not a significant issue for Icynene products. These factors include:

- Proportioners used in the application of spray foam have automatic shut-off controls that prevent spray if a significant off-ratio condition is encountered
- Installers are motivated to immediately remedy conditions because spraying off-ratio reduces the quality and yield (volume of foam produced) thereby reducing productivity.
- Even a slightly off-ratio condition will be obvious in terms of a changed appearance and reduced "sprayability" of the foam—Icynene sprayers are trained to recognise and remedy off-ratio conditions immediately.
- Guidance given to installers calls for them to remove off-ratio mixtures that have been sprayed before continuing with spray foam installation.

Off Ratio Foam

In 2012, Icynene Inc. undertook a research program to characterise the VOC off-gassing differences between "off-ratio" and "balanced" mixtures of the A-side and B-side chemicals used during the application of spray polyurethane foams. Air chamber measurements made on off-ratio and balanced foams were used to assess the magnitude of the differences in the VOC emissions between the foam types and to focus the efforts of a toxicological review of the measured VOCs.

- The research addressed both Open Cell (Low Density) and Closed Cell (Medium Density) foams.
- Both Open Cell and Closed Cell foams were tested by spraying at more than the highest possible degrees of off-ratio mixtures as allowed by the spray equipment (i.e. more than 500 psi positive pressure difference between the A-Side and B-Sides) resulting in both iso-rich foam formulations as well as resin-rich foams.)

Small scale test results were then modeled assuming off-ratio foam comprised the entire spray job in both a classroom and office setting.

Estimated Classroom and Office Indoor Air VOC Concentrations assuming all foam is extremely off-ratio.

Selected VOC from Off-ratio Formulations	Classroom Scenario (µg/m³)		Office Scenario (µg/m³)		Regulatory Thresholds (ug/m³)
VOCs selected within toxicological phase of the review					
Air Chamber Sampling Time Point	24 Hour	30 Days	24 Hour	30 Days	24,600 (ACGHI TLV)
Acetic Acid	0.0	4.4	0.0	14.4	
Acetone	0.0	2.3	0.0	7.4	31,200 (EPA RSL)
Chlorobenzene	3.5	0.0	11.3	0.0	52 (EPA RSL)
Decamethylcyclo-pentasiloxane	3.4	0.0	11.1	0.0	None identified
VOCs selected within regulatory phase of the review					
2,6-bis(1,1-Dimethyl)-4-methylphenol (BHT)	7.9	0.0	25.7	0.0	2000 (ACGIH TLV)
Acetic acid, 2-(dimethylamino)ethyl ester	3.3	0.0	10.8	0.0	N/A
1,2,3-Trichloropropane	12.7	0.0	41.5	0.0	0.3 (EPA RfC)
1-Methoxy-2-propanol (propylene glycol monomethy ether)	10.8	0.0	35.2	0.0	2000 (EPA RfC)
2-Methyl-2-pentenal	2.9	0.0	9.5	0.0	N/A
N,N,N',N'-Tetramethyl-1,3-propanediamine	132.2	0.0	430.7	0.0	N/A
N,N-Dimethylethanolamine	1057.6	10.6	3445.5	34.7	7400 (UK WEEL)
3-(Dimethylamino)propanenitrile	55.2	6.8	179.9	22.1	10,000 (Russian OEL)

Off Ratio Foam

This analysis intentionally produced off-ratio foams beyond the extremes of what would be expected in the field to conservatively overestimate any potential releases for the purpose of the study. To consistently produce such poor foam, it was necessary to modify the control software in the proportioning unit (i.e. over-ride the aforementioned shut-off) in a manner not available to installers. This approach assured that the samples produced were representative of extreme off-ratio and worse than anything that would likely occur in the field.

Dr. Eric Rosenblum Ph.D., DABT was engaged to research the toxicological profiles and regulatory thresholds for the compounds that were identified in the testing. Results from this study show that, even with extreme assumptions pertaining to both the installation of highly off-ratio foam, and the modeled approach used to estimate indoor air concentration, the evaluated VOCs were not present at concentrations that would present a health concern beyond 24 hours based on established regulatory thresholds. Therefore, based on this protective analysis, it was concluded that results for normal ratio and realistic volumes of off-ratio foam mixtures in a consumer setting are not of concern.

Icynene Successful Installs

Notwithstanding the extensive, third-party testing of Icynene spray foam products, some of the most convincing proof of performance comes with more than 25 years of installation history and hundreds of thousands of successful installations of the products.

Recently, Steve Weiss Consulting estimated that the number of successful installations of Icynene spray foam exceeded 350,000 homes. That estimate was based on the volume of products sold over the period divided by the average size of each job that was sprayed. This research confirms that spray foam insulation has a proven track record that can be confirmed with performance in hundreds of thousands of homes.

In Summary

Icynene spray foam has been widely tested for both insulation performance as well as health and safety. The testing shows that both when sprayed on-ratio and even off-ratio settings beyond what might be experienced in the field, the products are safe for workers when recommended personal protective equipment is worn and the 24-hour exclusion period is sufficient for residents. VOCs have been extensively studied and, in the opinion of third party toxicologists, within 24 hours buildings sprayed with Icynene are safe for re-occupancy.

Icynene specifically formulates its products to avoid use of catalysts and flame retardants that have been identified as undesirable on lists such as California's Proposition 65. Water blown light density formulations in particular cure quickly because the excess water quickly reacts with the MDI and pMDI of the A-side.

Icynene has been an industry leader selling to professional contractors and not selling its products through third party distribution or into the do-it-yourself market. Icynene has made it a priority to train all users of its products. A significant portion of Icynene and Spray Foam industry training is a focus on the safe handling of materials.

Proper Personal Protective Equipment (PPE) is required including Supply Air Respirators (SAR's), coveralls, gloves and masks to avoid inhaling vapours and particulates, protect against skin contact with raw materials, as well as providing a measure of safety around high pressure spray equipment.

While appropriately supervised on-site contractors and workers informed about the SPF application may re-enter the work area provided increased ventilation is supplied during spray and maintained immediately thereafter as recommended in this document, Icynene requires its installers to ensure that homeowners and others vacate the premises during installation and for 24 hours afterward, to create a safe environment for the installation of this product.

Safe application in more than 400,000 homes and commercial buildings over 25 years helps substantiate the fact that the Icynene's approach and Icynene products are safe and durable.

Visit **icynene.co.uk** or **icynene.eu** to learn more about Icynene's portfolio of H_2Foam open and closed cell spray foam insulation products.

For the most current product information, please consult the Icynene website. Icynene is a registered trademark of Icynene Inc.

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