THE DOVECHEM GROUP

PARAFORMALDEHYDE BASIC TECHNICAL INTRODUCTION

GROW & SERVE

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History

Founded in 1960, The Dovechem Group is one of the leading chemical group companies in Asia Pacific engaged in Distribution, Manufacturing, Terminal and Logistics for the petrochemical related industries.

PT. Dover Chemical, located in Merak, Banten, Indonesia was established as an Indonesia PMA chemical company under Dovechem Group in 1980.

PT. Dover Chemical produces formaldehyde, formaldehyde resins (UF, MF, PF, and PUF) used in the wood panel industries, such as plywood, particle board, medium density fibreboard (MDF) and household furniture, and also emulsion adhesives which are used widely in many industries.

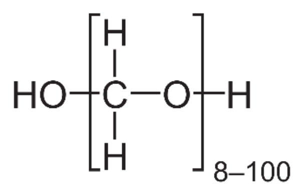
PT. Dover Chemical, as part of our commitment to Quality, Safety and the Environment have obtained certifications for ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007 as audited by SGS. We are a member of Responsible Care Indonesia and are audited by Chemical Distribution Institute – Terminals.

After more than 50 years in the chemical industry, in 2017 we develop paraformaldehyde. This new addition to our product list is our commitment to deliver the best product and services to the industry.

Introduction

Paraformaldehyde, commonly known as paraform, is formed by the polymerisation of formaldehyde with 8-100 units of monomer and is the smallest polyoxymethylene. It is a white solid polymer of formaldehyde with the pungent and characteristic formaldehyde odour and is widely used by resin manufacturers seeking low water content or more favourable control of reaction rates when compared to aqueous formaldehyde solutions.

Formula:



Paraformaldehyde is slightly soluble in alcohols and insoluble in ethers, hydrocarbons and carbon tetrachloride. It is relatively insoluble in cold water, but soluble in hot water with depolymerisation at elevated temperature. Once dissolved, the paraformaldehyde solution behaves like the methanol-free formaldehyde solution of the same concentration.

In two grades namely 92% and 96%, our supply will fit your purity needs as well. You can rely on our product supply as the sole producer of paraformaldehyde in Indonesia

Manufacturing Method

Formaldehyde is manufactured industrially by either catalytic oxidation of methanol or by a combination of catalytic oxidation and dehydrogenation of methanol. These two types of manufacturing methods are differentiated by the catalyst used.

a. Metal Oxide Catalyst
b. Silver Catalyst

The Metal oxide process is known as the total oxidation process. Its main characteristics are:

- High air/methanol ratio
- Predominantly oxidation
- Low content of methanol in product

The Silver process is known as the partial oxidation and dehydrogenation process. Its main characteristics are:

- High methanol/air ratio
- Partial oxidation and partial dehydrogenation
- Low content of formic acid in product

PT Dover Chemical produces formaldehyde with both the above processes and benefits from the better of the two. This in turn provides the advantage to produce paraformaldehyde starting from its choice of formaldehyde solution that has the least impurities. Paraformaldehyde is produced through a two-step concentration process followed by a drying process of the formaldehyde solution to finally obtain the solid dry prill form product. Polymerisation of formaldehyde to about 10 to 15 units of chain length takes place just before the drying process in the steady-state continuous chemical plant. Then the product is stored temporarily in a series of silos and transferred to the hopper to be packed using an automatic packing machine.

Physical Properties

Manufactured based on the latest technology to give good solubility, homogeneous prill and low acid content, it is suitable for all ranges of application of paraformaldehyde.

Form	Free Flowing Prill
Paraformaldehyde Content (%)	92 & 96
Impurities	
Acidity (%)	0.002
Iron (%)	0.001
Ash (%)	0.005
Particle Size (%v at between 100 and 1000 μm)	> 90
Dust content (%v at less than 63 μm)	< 3
pH (10% aq. sol)	4.0 – 7.0
Bulk Density (kg/m^3)	650 – 850
Melting Point (°C)	120 – 175
Reactivity (min)	2 – 8

Packaging

Standard package is 25 kg using a three-layer Polyethylene bag. Option for 500 kg package is possible depending on demand.

For market outside Indonesia, all quantities from 1 pallet (1 ton = 40 x 25kg) up to full container loads can be supplied.

The Paraformaldehyde Benefits

- High concentration with low water content
- Reduction of effluent problems
- Solid product
- Easy to store and transport

Solubility

Paraformaldehyde dissolves by first depolymerising to yield formaldehyde. This is often the rate-determining step in reactions of paraformaldehyde.

$$HO(CH_2O)_nCH_2OH \leftrightarrow HO(CH_2O)_nH + CH_2O$$

$$CH_2O \overset{H_2O}{\longleftrightarrow} CH_2(OH)_2$$

Dissolution of paraformaldehyde becomes more difficult as the molecular weight grows larger. This can become a problem if the paraformaldehyde has been stored for a very long time and especially at higher temperature.

The rate of depolymerisation can be catalysed by acid or base. With base catalyst, commonly sodium hydroxide or potassium hydroxide, hydrolysis takes place by stepwise removal of formaldehyde following attack on the terminal hydroxyl group. With acid catalyst, commonly sulphuric acid, cleavage can occur at any point of the polymer chain breaking it into smaller oligomers and increasing sites for subsequent hydrolysis. Very acidic conditions are necessary to achieve the same depolymerisation rate as can be achieved under mildly alkaline conditions.

Dissolution of paraformaldehyde is an endothermic reaction. Therefore heating is usually required when dissolving paraformaldehyde. In practice, it is more convenient to charge paraformaldehyde and other co-reactants together especially if the reaction is exothermic. In addition, reaction of formaldehyde as it is released from its polymer chain especially under alkaline conditions, helps to minimize Cannizzaro reaction.

Vaporisation

Paraformaldehyde decomposes and vaporises on heating. It will vaporise slowly even at room temperature. This is regarded as sublimation process.

The following table gives an indication of the variation of vapour pressure of formaldehyde (*p*) released from paraformaldehyde.

t, °C	10	21	25	33	37
p, kPa	0.112	0.165	0.193	0.408	0.667
t, °C	43	47	51	58	65
p, kPa	0.943	1.096	1.376	1.808	20.8
t, °C	80	90	100	110	120
p, kPa	32.8	44.1	49.6	53.5	78.3

Test Methods

1. **Sampling Procedures**

Concentration gradients can exist within the pack. If there is a temperature gradient between the core and the surface it will cause migration of free water. For example it can become moist on the surface sampling if transferred from warm to cold environment.
Please mix the paraformaldehyde thoroughly before taking specimen for analysis. It is necessary to use a core sample to have a representative result.

2. **Formaldehyde Content - Sulphite Method**

Measure freshly prepared sodium sulphite solution into a conical flask. Then add:

a. A magnetic stirrer bar
b. 2 - 3 drops of thymolphthalein indicator
c. Sodium hydroxide dropwise, if necessary, until the solution turns blue
d. Sulphuric acid carefully dropwise until the solution is just colourless,
e. Sample of paraformaldehyde sufficient to contain 1.2 to 1.3 g formaldehyde

Stir until the paraformaldehyde has completely dissolved. Titrate with accurately standardised sulphuric acid until the solution is just colourless.
Do not tip paraformaldehyde from a plastic vessel into the sodium sulphite. Static electricity may cause transfer errors.
Calculate the weight percent of formaldehyde content according to:

$$\%Formaldehyde = \frac{titre\ (ml) \times acid\ normality \times 3.003}{sample\ weight\ (g)}$$

Besides the Sulphite method, other methods to determine the formaldehyde content are available such as the Refractive index method and the Gas chromatography method. The refractive index method is more rapid but less accurate whilst the Gas chromatography method is more time-consuming but generally gives a higher precision result.

3. **Ash Content**

a. Weigh paraformaldehyde (25 ± 0.1 g) into a pre-ignited, pre-weighed silica crucible
b. Ignite gently using a Bunsen burner and allow to burn naturally.
c. Ignite to constant weight in 2 hours at 850 to 1000°C. Cool in a desiccator and re-weigh.

Note that use of a platinum crucible can cause error giving higher results.
Calculate the weight percent of ash content according to:

$$\%Ash = \frac{weight\ of\ ash \times 100}{sample\ weight\ (g)}$$

4. Resorcinol Reactivity

Formaldehyde reacts exothermically with resorcinol. When paraformaldehyde is reacted with resorcinol the resultant exotherm rate gives a measure of the depolymerisation and reaction capability of the paraformaldehyde.

a. Dissolve resorcinol (50 g, technical grade or better) in sodium hydroxide solution (50 ml, 1.0 N), or multiples thereof. Maintain this solution in an airtight container at 25°C. Use within three days.

b. Keep the magnetic stirrer and stirrer bar, insulated beaker and thermometer in a glass-fronted cabinet at 25°C, to ensure temperature equilibration.
Ensure that this cabinet has a cooling capacity to overcome the heating effect of the magnetic stirrer.

c. Measure resorcinol/sodium hydroxide solution (50 ml) into a 100 ml glass squat-form beaker with insulation jacket at sides and bottom.
Note that the thermal capacity of the beaker can influence the observed exotherm rate. A plastic beaker should not be used. The weight of the glass beaker should be as consistent as possible, preferably 60 ± 10 g when without insulation.

d. Place the beaker on the magnetic stirrer. Adjust thermometer support to give satisfactory immersion depth. Add the magnetic stirrer bar and adjust stirring rate (vortex depth 5 to 10mm). Stop the stirrer.

e. Add paraformaldehyde fine prill (10 ± 0.1 g) into the beaker.
Note that the sample must first be ground to 150 μm (92% grade) or to 70 μm (96% grade) before use for testing.

f. Start the stopwatch. Stir with the thermometer to ensure quick and thorough mixing.

g. Note the initial mix temperature immediately after mixing. Position the thermometer in its support and start the magnetic stirrer. Close the cabinet door and keep it closed for the duration of the test.

h. Observe the exotherm. Stop the stopwatch when the temperature reaches 60°C. Note the time elapsed since paraformaldehyde addition.

Report the result for Resorcinol reactivity time (RRT) in minutes.

If the initial mix temperature deviated from 25.0 °C by more than 0.5 °C but less than 1.0 °C, correction factors may be applied to the results. Contact us for the complete test method.

5. Particle Size Distribution

Particle size distribution is measured using a Malvern Particle Size Analyzer (PSA) Mastersizer 3000 (by laser diffraction technique).

Dry measurement with sample transportation gas pressure of 0.5 ± 0.03 bar.g and run time 5 seconds.

Handling & Safety

Use adequate ventilation. Keep in a dry, cool and well-ventilated place.

Do not breathe vapours or dust. Avoid contact with skin, eyes and clothing. Wash thoroughly with soap and water after handling. Remove any contaminated clothing and launder before reuse. Refill and handle product only in a closed system. Provide sufficient air exchange and/or exhaust in work rooms.

Paraformaldehyde decomposes to formaldehyde which can build up in a shipping container depending on time and temperature during transit. The level of formaldehyde exposure may be instantaneously high when the shipping container is opened.

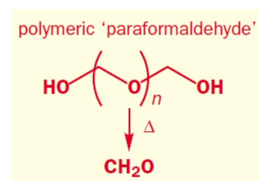
Store in locked up. Location of storage should only be accessible to authorised personnel. Separate storage area from work place.

To obtain a Safety Data Sheet (SDS) or a Handling Guide for Paraformaldehyde, please contact us by telephone or send your request via Email using the Contact Us on www.dovechem.co.id

Applications of Paraformaldehyde

Formaldehyde is an extremely reactive aldehyde as it has no substituents to hinder attack. Formaldehyde hydrates completely having an equilibrium constant *k* of 2280, as compared to acetone (0.001) and acetaldehyde (1.06). This is why aqueous solution of formaldehyde contains essentially no CH_2O – it is completely hydrated.

However, "cracking" of paraformaldehyde can provide monomeric formaldehyde in anhydrous solution.



The most commonly known use of Paraformaldehyde is as a preservative. Today, paraformaldehyde and its reaction products are an important part of everyday life. The applications are very varied, reflecting the diversity of reaction which Paraformaldehyde can undergo. The applications of Paraformaldehyde can be divided into three broad groups:

1. Polymers

This is the largest use of paraformaldehyde. The most commonly encountered are amino and phenolic resins. When a triamine such as melamine reacts with formaldehyde, branched polymerisation can occur. Further condensation with formaldehyde allows amines to be attached in many places, and each new amine itself adds many new growing points until an exceptionally strong polymer results. These resins are used to make "unbreakable" plastics plates and for the famous kitchen surface "Formica". Partly polymerised melamine-formaldehyde mixtures are layered with other polymers such as cellulose and phenol-formaldehyde resins and the polymerisation is completed under pressure and heat. The result is the familiar, tough, heat-resistant surface.

Paraformaldehyde is also used in making a variety of specialty polymers, such as methyl 2-cyanoacrylates or more commonly known as SuperGlue. The monomer in the SuperGlue tube polymerises on to any surface (wood, metal, plastics, lips, eyelids, fingers, etc.) catalysed by traces of moisture or air, and the bonds once formed are very difficult to break.

Acetal resins also forms an important use of paraformaldehyde. Acetal resin is a highly-crystalline engineering thermoplastic for high load mechanical applications such as gears, door systems, safety restraints, conveyor belts. It is also used in dental restorative applications.

2. Raw Material for Chemical Production

Paraformaldehyde is one of the most reactive organic chemicals.
The two main modes of reactions are reduction and addition.

1) Reduction: Paraformaldehyde is a powerful reducing agent, especially in alkaline medium, being itself oxidized to formate or formic acid.
2) Addition: Paraformaldehyde adds easily in place of active hydrogen atoms, introducing one or more hydroxymethyl (methylol) groups. These may then take part in other reactions, including polycondensation. Methylolation reactions are usually reversible. The methylol group can act as a formaldehyde donor.

The variety of reactions make Paraformaldehyde one of the most useful agents in chemical synthesis.

3. Biocides and Preservatives

Paraformaldehyde is an effective disinfectant in both gaseous and solution forms. It has particular advantage of being not just bactericidal but also sporicidal, fungicidal and virucidal. Relatively low cost and versatility of handling make Paraformaldehyde useful in many applications. Additionally, Paraformaldehyde is biodegradable at low concentrations.

Common applications of Paraformaldehyde are:

- **Abrasives**
  Both phenolic and amino resins are used for manufacture of abrasive papers, especially as a topcoat. The water resistance of phenolic make them particularly suitable for use in wet-or-dry papers. For grinding wheels, ceramic binders are the most common. Their rigidity is particularly important for precision grinding. Phenolic binders are used in a smaller but important amount especially for rough grinding and cutting wheels.

- **Agriculture**

  Paraformaldehyde is widely used in agriculture for a variety of sterilisation/fumigation/preservative purpose. Paraformaldehyde may be used as powder, spray, dip or vapour, depending on the application. Paraformaldehyde is frequently specified as a sterilising agent during outbreaks of contagious disease such as Foot and Mouth, or the sugar beet disease Rhizomania.

- **Amino Resins**

  These are thermosetting resins, produced by condensation co-polymerisation of Formaldehyde with various amides. As a class they are the largest single consumer of Formaldehyde. The most important types are Urea-Formaldehyde (UF) and Melamine Formaldehyde (MF).

- **Analysis**

  Paraformaldehyde is used as a reagent in numerous qualitative and quantitative analytical methods.

- **Chemical Toilets**

  Paraformaldehyde is used as the main active component in preparations for uses in chemical toilets. The main purpose of the Paraformaldehyde is as a bactericide, where it remains effective at concentrations down to 0.1 %. Paraformaldehyde has the additional advantage that it genuinely deodorizes the contents of the toilet. Paraformaldehyde-based chemical are used in aircraft toilets (standard AMS1475A, year 2011).

- **Chelating Agents**

  The manufacture of chelating agents such as ethylene diamine tetra acetic acid (EDTA) and nitrilotriacetic acid is an important application of Paraformaldehyde. Such chelating agents are widely used in detergents and electroplating processes.

  Another important application is aromatic hydroxy oximes which is made by reacting Paraformaldehyde with substituted phenols. These chelating agents are used for selective extraction of copper from solutions derived from oxide ores.

- **Concrete and Plaster**

  Sulphonated Melamine Formaldehyde (SMF) or sulphonated naphthalene formaldehyde (SNF) resins can be used as plasticizers for concrete. They can be used to improve the flow properties of the concrete and to permit reduced water content. Road construction needed to complete before winter time arrives was often added with SMF or SNF to speed up the hardening process.

- **Cosmetics**

  Paraformaldehyde is often used at low concentration as a preservative in cosmetics. It is also used in toothpaste, mouth washes and germicidal soaps. Paraformaldehyde may be used as a hardener in nail varnishes. Paraformaldehyde reacts with proteins, causing cross linking and hardening.

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- **Cyanoacrylate Adhesives**
  Cyanoacrylates give a high quality bond with a wide range of substrates. Of particular value is their rapid cure and relative ease of application. As a bonus, they are normally solvent-less. They are now commonly used as a medical adhesive for closing of wounds. Paraformaldehyde is the preferred source of Formaldehyde.

- **Deodorants**
  Paraformaldehyde is a true deodorant. It fulfils two functions in deodorisers. It reacts with compounds responsible for the bad odour (for example, amines, hydrogen sulphide and mercaptans) to form less volatile products. Further, it kills the bacteria responsible for decay. In additions to its use to deodorants, Paraformaldehyde may be used to deodorise blubber, glue, factories, leather, skins and hooves, abattoirs etc.

- **Dyes and Dye house Chemicals**
  An important application of Paraformaldehyde is in manufacture of phenylglycine, in the syntheses of indigo. Many dyes are produced by condensing Paraformaldehyde with amines. For example, Lithol Fast Yellow is obtained from chloro-6-nitro aniline.
  Paraformaldehyde sulphoxylates such as sodium and zinc sulphoxylates are used as dye stripping agents.

- **Electro-less Plating**
  This is an important application of Paraformaldehyde. The reducing actions of Paraformaldehyde is utilized in special formulations to deposit copper from solutions of its salts. Typical uses are in the manufacture of printed circuit boards, screening of computers and to provide a conductive base in electroplating of plastics.

- **Embalming**
  Paraformaldehyde is the main active ingredient of most embalming fluids. In additions to its preservative action. Paraformaldehyde hardens tissues by cross linking proteins. Paraformaldehyde is blended with other agents, such as alcohol, glycerol and phenol to aid penetration and produced the desired cosmetic effect.

- **Fibres**
  Phenolic resins such as Kynol have good fire resistance. The fibre does not burn but carbonizes in a flame. In doing so it retains its form and some of its strength.

- **Filters**
  Phenolic resins are used in the manufacture of oil, fuel, and air filters for automotive uses. Resin impregnation gives the paper the necessary strength and swelling resistance, whist still retaining porosity. The process involves impregnation, partial cure, cutting and folding, followed by final curing.

- **Firelighters**
  Firelighters are commonly based on kerosene, held within a solid matrix of cured UF resin. Kerosene, UF resin and surfactant are emulsified, an acid catalyst is added and the mixture is immediately formed in a mould. Other fuels, such as peat, can be incorporated.

- **Flame Retardants**
  THPC (Tetrakis Hydroxymethylphosphonium chloride) forms the basis of an important flame retardant system for textiles. It is produced by reacting formaldehyde with phosphine and hydrochloric acid.
  THPC is reacted with urea to form a precondensate. This is then applied to fabrics followed by curing with ammonia and oxidation with hydrogen peroxide.

- **Foundry Resins**
  Paraformaldehyde is used to make resin binders for the production of foundry moulds. The types of resins used can be phenolic, furane, melamine and urea-based.

- **Friction Materials**
  The excellent heat resistance of phenolic resins makes them ideal for use in manufacture of brake and clutch linings. The resins are used as a binder for fibres and fillers, in the forming of lining. Additionally, cured phenolic resins are used to make friction dust, which gives improved wear and more constant coefficients of friction.

- **GRP**
  Glass reinforced plastic is well known, especially that made from polyester resin. This material is widely used for moulded shapes where good strength and rigidity are required. This material offers the advantage of good fire resistance and low smoke emission. It is of considerable interest for aircraft and other transportation applications. Phenolic GRP represent a significant growth area for Paraformaldehyde usage as well as a major contribution to safety.

- **Ink**
  Modern high speed printing processes require rapid drying inks. Phenolic resins, either pure or co reacted with natural rosin, are used. These may be mixed with other resins to reduce cost modify properties. Inclusion of such resins improved durability of the resultant print.

- **Insulation**
  Urea Formaldehyde (UF) foam is well known, especially for its use in insulating cavity walls. This material has good fire resistance and low smoke emission.

- **Ion Exchange**
  Paraformaldehyde is used in production of ion exchange resins. The process involves chloromethylations of the polystyrene substrate.

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➢ **Laminates**

Decorative laminates are widely used in the furniture industry, especially as a surface finish for clipboard. They are made from resin–impregnated paper. There are two main types:

1. Low pressure laminates are usually a single layer of MF or MUF impregnated paper, dried and part cure*d*.
2. High pressure laminates are multi-layer, having phenolic impregnated core MF or MUF. These are more durable than low pressure laminates and are commonly used for kitchen worktops. High pressured laminated are pre cured as a composite and bonded to the substrate by separate adhesive.

Phenolic or melamine resins are used to produce a wide variety of industrial laminates including:

- Printed Circuit Boards
- Battery electrode separators
- Chemically resistant plant. Used for component ranging from pipes or stirrers up to complete reactors.
- High performance engineering components.

➢ **Leather**

Paraformaldehyde may be used alone for tanning of leather or blended with other tanning agents. Inclusion of urea or melamine gives methylol compounds which impregnate the skin and resinify. Paraformaldehyde is also used for disinfection of crude hides and for dressing of leather goods, fur and hair.

➢ **Medicine**

The best known medical application of Paraformaldehyde is the preservation of anatomical specimens. Paraformaldehyde is also used for general disinfection purpose. Paraformaldehyde is widely used in the preparation of vaccines. It has the advantage that it can render viruses' non infective without interfering with their antigenic properties. Salk used paraformaldehyde in preparing poliomyelitis vaccine.

Paraformaldehyde is also used to prepare fresh formalin 4% solution in immunohistochemistry as fixation agent.

Paraformaldehyde is used in the manufacture of several vitamins and its use is reported for the synthesis of many drugs. Paraformaldehyde is widely used by pharmaceutical manufactures for plant sterilization purpose.

➢ **Moulding**

Moulding compounds are produced using PF, MF or UF resins with wide range of fillers (For Example Cellulose, Wood Flour, mica, textile fibres). UF moulding compounds are typically used to make electrical sockets, switches and fuse boxes. PF Moulding compounds tend to be used where good heat resistance is required such as saucepan handles or vehicle distributor caps. Phenolic resins with mineral fillers provide casting resins which can be used to make bowling balls and snooker balls for example.

- **Oil & Gas**

Paraformaldehyde is commonly used as a preservative to prevent bacteria degradation of the mud. Hydrogen sulphide can cause major corrosions problems in oil well equipment. Paraformaldehyde can give protection being an effective hydrogen sulphide scavenger. Paraformaldehyde has many uses in hydrocarbon refining, such as separation of meta- xylene from the ortho- and para- isomers.

Paraformaldehdye is also used to make various lubricants and triazines that are used for Oil & Gas operations.

- **Paper**

Paraformaldehyde reacts with cellulose. It is reported that direct treatment with Paraformaldehyde improve the wet strength of paper but in practice this is achieved by using amino resins. Wet strength is especially important in applications such as packaging, paper towels, and tissues, filter papers, photographic papers, banknotes. Paraformaldehyde is used with proteins such as casein or gelatin to improve water resistance in coating of paper and cardboard. Paraformaldehyde or amino resins are also used with starch in coating applications.

- **Phenolic Resins**

These are condensation co–polymers of phenols with formaldehyde. Phenolic resins are divided into two main groups:

1. Resols have F/P molar ratio greater than 1 and are heat reactive resins.
2. Novolacs have F/P molar ratio less than 1. Novolacs are formaldehyde deficient and are essentially non-reactive, alone. It necessary to add formaldehyde to achieve cure. This is usually accomplished via hexamine or paraformaldehyde.

As with amino resins, phenolic resins are thermosetting. They have generally better heat and water resistance than do amino resins.

- **Photography**

Although digital photos are more common nowadays, where colour films are still used paraformaldehyde is incorporated in stabilisers used in processing of the colour films. It prevents fading of the talent image by hardening the gelatin in the emulsion. Paraformaldehyde is also used as hardeners for some monochrome films.

- **Proteins**

Paraformaldehyde reacts with proteins causing cross linking and hardening. It is this reaction which causes hardening and cracking of skin which has been excessively exposed to Paraformaldehyde. Conversely, small quantities of Paraformaldehyde can be added proteins as a preservative and may even improve their solubility.

- **Rubber**

Phenolic resins are used as reinforcing agents for both natural and synthetic rubbers. Typically a phenolic novolac is cross linked with the rubber using hexamine, prior to vulcanization. Paraformaldehyde may be used as a preservative for rubber latex, or for neutralization of ammonia. In latex it may also be used for gelling and coagulating rubber dispersions and in vulcanization for special purpose. Indirectly, Paraformaldehyde may also be used in rubber production via its use in the synthesis of dienes.

- **Silage Additives**

  Paraformaldehyde is used in the manufacture of additives to minimize this degradation. It is most commonly used in conjunction with acid (example sulphuric or formic) when the bactericidal action of Paraformaldehyde is assisted by the effect of reducing pH.

- **Sugar**

  Paraformaldehyde is used to prevent degradation by soil borne bacteria in the manufacture of sugar from sugar beet. Conditions in the diffuser (where the beet is digested) are monitored chemically for degradation products (especially lactic acid) and rate of Paraformaldehyde addition adjusted accordingly.

- **Surface Coatings**

  Phenolic resins also are used in surface coatings, although their colour tends to restrict their range of application. Phenolic resins are particularly important where corrosion or chemical resistance is required. Typical application are tanks lining, automotive primers, Can Coatings. Modified phenolic are often used with chlorinated rubber coating compositions for marine antifouling paints.

- **Surfactants**

  Paraformaldehyde is used in the manufacture of many surfactant. The main value of Paraformaldehydes is that it can be used to introduce solubilizing group into chains.

  Surfactant can also be produced by using paraformaldehyde to link other molecules which already contain the necessary active groups to increase molecular weight. Numerous other types involve the use of Paraformaldehyde. Paraformaldehyde is widely used as an additive to prevent bacterial degradation of surfactants.

- **Textiles**

  Formaldehyde reacts with cellulose and many other textile materials and was once used directly to improve their properties.

  DMDHEU reactants (Formaldehyde/ Glycol/ Urea) are widely used for the production of ease care finishes, particularly on polyester/ cotton blends processed by single pass 'flash-cure' technique. Modified glycol resins are becoming increasingly popular because they lower releasable formaldehyde levels on the finished fabric. Cationic resins may be used for special purpose such as garment finishing. Dicyandiamide – formaldehyde resins are commonly used as dye fixing aids.

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Frequently Asked Questions

- What is the difference between formaldehyde and paraformaldehyde?
  - *Paraformaldehyde is the polymeric form of formaldehyde. Paraformaldehyde is a solid, and formaldehyde is a gas. An aqueous formaldehyde solution known as formalin consists of formaldehyde gas hydrated in water (or of paraformaldehyde depolymerises in water then further hydrated) to form methylene glycol.*
- How long can I keep Paraformaldehyde before use?
  - *Guarantee of quality is 1 year from the time of receipt for unopened package stored at below 35°C.*
- How stable are Paraformaldehyde dissolved in water?
  - *Stability of formaldehyde aqueous solution depends largely on the concentration and temperature of storage. Generally formaldehyde solution 45%w/w stored at 50°C can be stable for at least one month, but at 30°C only one week.*
- How to prepare solutions of Paraformaldehyde?
  - *Paraformaldehyde does not dissolve but rather can be depolymerised in solution. Depolymerised paraformaldehyde in solutions can be prepared in water with heating to 55-60°C. If necessary, further addition of sodium hydroxide to pH 10 where required.*
- Which document(s) contains expiration date information for a given product?
  - *The recommended expiration date can be found on the Certificate of Analysis.*
- How do I get lot-specific information or a Certificate of Analysis?
  - *A Certificate of Analysis is available by lot number.*
- What is the Department of Transportation shipping information for this product?
  - *Transportation information can be found in the Safety Data Sheet.*
- My question is not addressed here, how can I contact Technical Service for assistance?
  - *Drop us an email or give us a call. We'll get back to you once we receive your message.*