KUMHO P&B
CHEMICALS

PHENOL

PHENOL	DATA SHEET

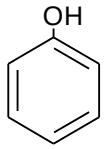
Description

Phenol is a white, crystalline compound with an easily recognized aromatic odor.

Phenol is used to produce a wide variety of chemical intermediates, including phenolic resins, bisphenol A, caprolactam, alkyl phenols, adipic acid, plasticizers and others.

Phenol is a versatile industrial organic chemical. The largest end use of phenol is in phenol-formaldehyde resins used in wood adhesives, as well as molding and laminating resins, paints, varnishes and enamels.

Phenol is also used in the manufacturing of preservatives and disinfectants, lubrication oils, herbicides, insecticides, pharmaceuticals and in many other applications.



Phenol, Carbolic acid, Phenylic acid, Benzophenol, Hydroxybenzene

Uses

Phenol Formaldehyde Resins

The reaction product of phenol and formaldehyde has been in widespread use since the expiration of the basic patents in 1926. Phenolic resins, because of their tough, durable, wear resistant nature and di-electric properties, are used as molding powders, laminates, adhesives and coating resins.

Molding Resins

Phenolic molding resins are normally produces as powders, which are molded into a number of products such as telephone housings and electrical outlets or plugs. Other substances such as

lubricants, fillers, catalysts and dyes are incorporated into the molding resin. Fillers such as wood flour or asbestos are used to extend and to impart special properties to the molding powder, while the lubricants - usually waxes of soaps - facilitate the removal of the molding piece.

Laminates

These are produced by saturating or impregnating base materials with a solution of a phenol resin and, by the application of heat and pressure, curing the resin and bonding the base material. The most commonly used materials for the base are paper, cloth, wood and glass fibers. These laminates are normally characterized by the pressure at which they are molded.

High pressure lamination is generally used for structural parts such as rods, sheets, tubes, angles and channels, which are further fabricated into final form. These laminates find extensive use in the electrical industry and in such materials table and counter tops, wall panels and chemically resistant containers. Low pressure lamination requires less complex equipment. A wide variety of products, including many large shapes, are produced by this method. These inclued boat hulls, airplane parts, luggage, building materials, brake linings and many others.

Adhesives

Wherever a strong, durable and water resistant bond is required, phenolic adhesives can be used. By far the greatest use of these adhesives is in the manufacture of marine or exterior grades of plywood. In addition phenol-formaldehyde adhesives are being used in increasing amounts by manufacturers of abrasive wheels and belts, insulation, brake linings and shoes, and gaskets. These resins have setting temperatures from room temperature to above 100℃

Protective Coatings

The resistance provided by phenolic resins makes them useful in marry coating applications, including varnish, enamel and lacquer formulations. Baked phenolic coatings are used for tank linings and similar applications because of their, excellent resistance to heat and to most chemicals. The reaction of certain modified phenols with formaldehyde produces resins which form fast drying, tough and chemical-resistant coatings. The use of dispersed but completely polymerized phenolic resins results in excellent primers for use on steel and aluminum.

Petroleum Industry

Phenol and phenol derivatives are used in both the refining and compounding of petroleum products. Phenol, alone or mixed with other solvents, is used in counter current extraction to remove undesirable constituents from lube oil stocks. Phenol is also a primary raw material for the production of many stabilizers or antioxidants for motor oils. These materials it is thought, direct the oxidation to minimize sludge and to inhibit corrosion. The exact chemical composition of lube oil additives differs, but in general the additives are highly alkylated phenol sulfides. In the

manufacture of toluene from petroleum fractions a complex mixture of chemicals is produced which cannot be separated by normal distillation. With the addition of phenol to the reaction products, the higher fractions can be distilled and the toluene separated from the phenol.

Preservatives And Disinfectants

Phenol is used in a great many preservative applications in leather, cutting oil, textile and other industries. Phenol, which is carbolic acid, has been used for years as a disinfectant in hospitals and for many other sanitary applications.

Other Applications

Phenol is the starting material for the production of salicylic acid a compound useful as a rubber vulcanization inhibitor and as an intermediate in the production of medicinal compounds, flavorings, and cosmetics. The alkylation of phenol yields substituted phenols, which are employed in the production of modified phenolic resins, surfactants, weed killers and fungicides. Chlorinated phenols find application as fungicides and germicides, and as intermediates for dyes, plasticizers, agricultural chemicals and veterinary medicines.

Sales specification

Property	Unit	Value	Test method
Molten color	Pt-Co	20 max.	ASTM D 1686
Water content	% wt	0.1 max.	ASTM D 1364
Solidification point	℃	40.7 min.	ASTM D 1493
Purity	% wt	99.7 min.	SMS 1751

● *Purity, %wt = 100 %wt – (water content, %wt + Total G.C impurities, %wt)*

Typical Properties of Phenol

Property	Unit	Value
Appearance		White crystalline(at room temperature)
Autoignition temperature	℃	715(1319°F)
Boiling point, at 760mmHg	℃	181.8(359°F)
Coefficient of expansion		0.00085 /℃(approximate)
Color		Colorless to light solid or white molten liquid
Critical pressure(atm)		60.5
Critical temperature	℃	419℃(786°F)
Deliquescent		Yes
Density	kg/ ℓ	
25℃		1.071
50℃		1.050

Dielectric constant, at 48℃		9.9
Empirical formula		C_6H_5OH
Explosive limit in air, lower	% v/v	1.5
Flammable limits	%	Lower limit approx. 1.5
Flash point		
Tag open cup	℃	85(185°F)
Closed cup	℃	79(174°F)
Freezing point	℃	40.8(105 ℓ)
Heat of Combustion	(cal/g)	-7754
	(Btu/lb)	-13957
Heat of Fusion	(cal/g)	29.22
	(Btu/lb)	52.6
Heat of Vaporization at b.p.	(cal/g)	116.6
	(Btu/lb)	210
Light sensitive		Yes, darkens slowly on exposure to light
Molecular weight		94.11
Odor		Characteristically sweet
Odor threshold	ppm	0.05 ~ 0.5
Physical state		Liquid or solid

Property	Unit	Value
Reactivity		Stable
Solubility		
Water 16℃(61°F)		6.7g / 100 ㎖
66℃(151°F)		All proportions
Alcohol		Soluble
Specific Gravity at 25/25℃		
1% aqueous solution		1.0009
2% aqueous solution		1.0025
5% aqueous solution		1.0044
Specific Gravity		
Solid at 25/4℃		1.132
Liquid at 41/4℃		1.0576
Liquid at 60/4℃		1.0413
Specific Heat (cal/g/℃)		
Solid at 4.0℃		0.296
Solid at 22.7℃		0.338
Liquid at 70-74℃		0.531
Surface tension at melting point	(Dynes/cm)	37.9
Threshold limit value(8 hours)	ppm	5 or 19mg/㎥
Vapor density(Air = 1)		3.24
Vapor pressure at 25℃	mbar	0.29
at 50℃		3.5
at 100℃		54
at 160℃		530
Viscosity at 45℃	centistokes	3.8
at 60℃		2.47
at 80℃		1.56
at 100℃		1.09

Physical Properties depend on Temperature

Temp ℃	Vapor Pressure mm Hg	Liquid Density g/ml	Liquid Density lb/gal	Viscosity Centistokes	Latent Heat Of Vapor Btu/lb²	Temp ℉
41	1.3	1.0579	8.826	-	250.5	106
50	2.5	1.0499	8.762	-	248.8	122
60	4.7	1.0413	8.690	2.520	245.7	140
70	8.7	1.0327	8.618	-	243.2	158
80	15.2	1.0241	8.546	1.597	240.4	176
90	25.6	1.0154	8.474	-	237.7	194
100	41.1	1.0068	8.402	1.084	235.0	212
110	64.2	0.9982	8.330	-	232.3	230
120	97.3	0.9894	8.257	0.851	229.3	248
130	143.6	-	-	-	226.4	266
140	206.6	-	-	-	223.4	284
150	298.7	-	-	-	220.3	302
181.75	760.0	-	-	-	205.7	359.2

Figure 1:
Congealing Points Of Phenol-Water Mixture

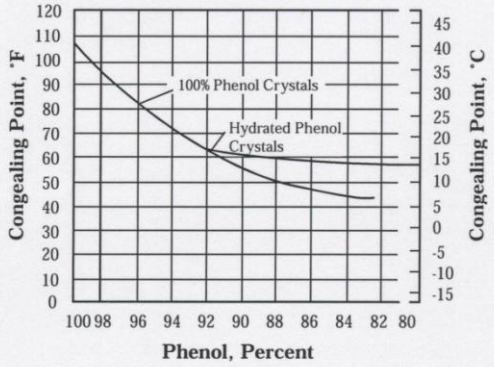


Figure 2:
Phase Diagram For The Phenol-Water System

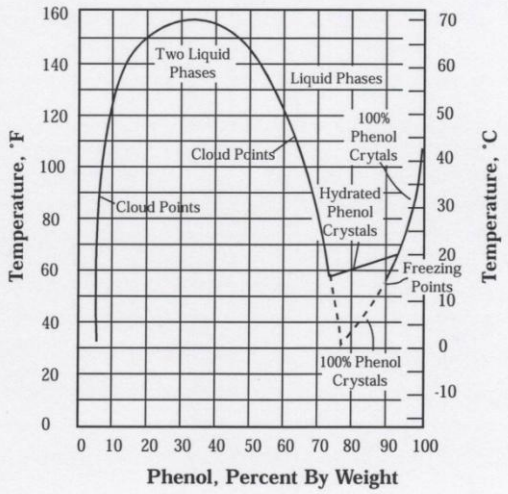


Figure 3:
Weight Per Gallon Of
Phenol At Various Temperatures

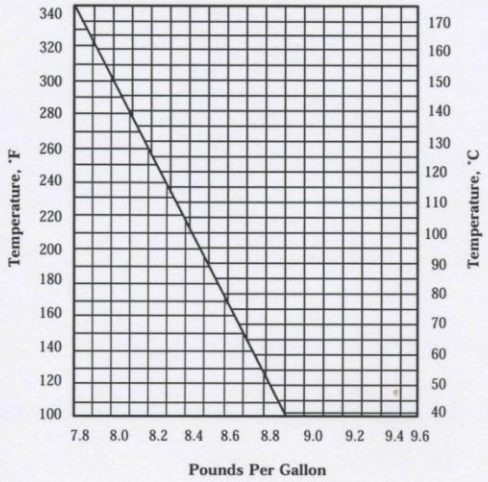


Figure 4:
Specific Gravity Of Phenol
Solutions At 20°C And 25°C

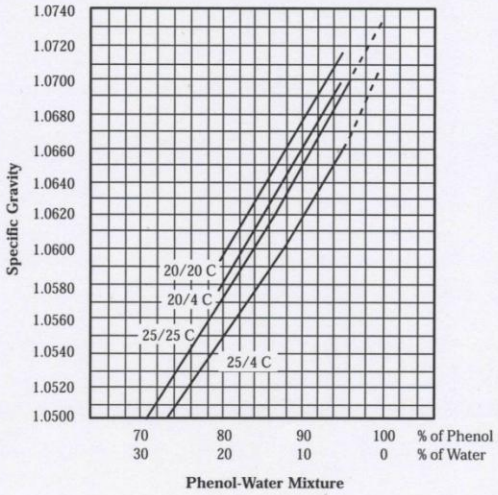


Figure 5:
Refractive Index Of Phenol
Solutions At 25°C

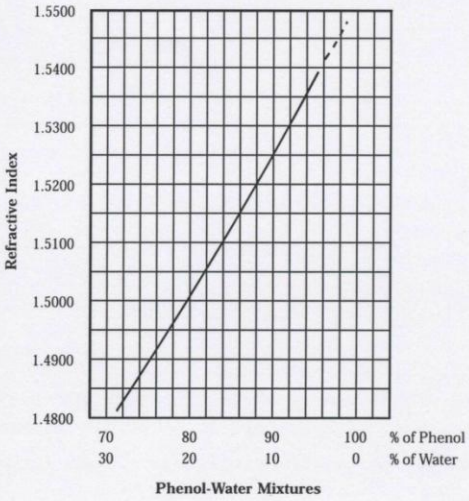
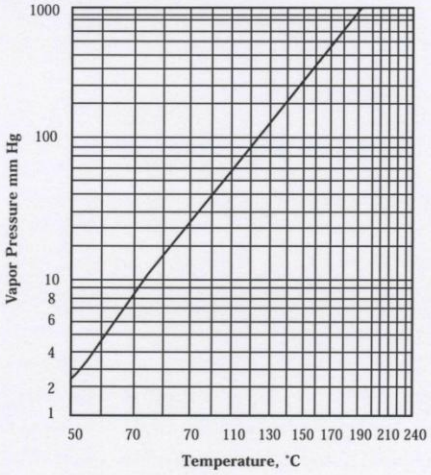


Figure 6:
Vapor Pressure Of Phenol
At Elevated Temperatures



Sampling

Face shields, neoprene rubber gloves and the other protective clothing required for unloading should be worn when sampling. Samples should be taken with a bottle held in a nickel, stainless

steel or other suitable metal sheath and suspended by a light nickel or stainless steel chain (in preference to wire). An ordinary three gallon pail is useful to receive the dripping sampling bottle, metal cage and chain as they are withdrawn from the tank car of molten phenol. If temperature readings are desired, use an enclosed scale thermometer. Hot phenol soon removes the ink or paint from and ordinary scale thermometer, making it extremely difficult to read.

Materials Of Construction

In applications where phenol color is unimportant, steel equipment gives years of satisfactory service. When colorless phenol is required, nickel or nickel clad steel tanks with nickel fittings are recommended how ever, unlined stainless steel or carbon steel tanks which have been lined with certain coatings have been found acceptable for storing the phenol used in most applications. For low color phenol, lines of nickel or stainless steel are essential. Phenol contact with certain metals should be avoided. Phenol is highly corrosive to aluminum. Magnesium, lead and zinc are quickly attacked by hot phenol. Phenol is easily discolored by copper and copper alloys.

Storage Tanks

Storage tanks should be of welded construction. Both vertical and horizontal tanks are suitable for phenol storage. Underground storage tanks should not be used because of the difficulty of finding leaks. Diking, drainage and tank supports should be designed to conform with local regulations. A rule of thumb commonly used for determining the size of storage facilities suggests that storage facilities be 1 1/2 times the size of shipments received. Some processes may require larger inventories.

Relief devices should be installed to provide venting and to relieve excess pressure and vacuum. These devices should be steam traced. Environmental considerations may dictate more elaborate venting equipment. In special applications where moisture content of phenol is important, special venting precautions or inert gas padding is required. Additional data covering these special situations will be provided upon request.

The storage tank inlet should be located at the bottom of the tank. Should a top inlet be desired, be sure to extend fill pipe nearly to the bottom of the tank to minimize static electricity during filling. The fill pipe should be connected electrically to both the tank flange and the transfer pipe line. The purpose of this electrical connection is to drain off any static charge which builds up during filling. A 1/4inch hole should be drilled in the top of the fill pipe just inside the tank to prevent phenol from siphoning back through the fill line.

Phenol is usually stored as a liquid at temperatures between 45℃ and 55℃. If colorless phenol is required, storage temperatures above 60℃ are not recommended. The tank should be nitrogen padded to prevent oxidation of phenol.

The heating pads can be steam or electric. Usually, heat padding is placed intermittently over the

bottom fifth to third of the tank. In addition, a vertical column of padding running the entire height of the tank should be present. This allows a fluid upward corridor for any liquid phenol expanding from the tank bottom. The entire tank should be appropriately insulated.

Internal pencil coils can also be used to maintain temperature in phenol storage tanks. Coils offer the advantage of faster heat-up time than external pads an advantage if phenol storage is less likely to be continuously maintained at elevated temperatures. But internal coil systems, if not properly operated and maintained, are more likely to develop leaks and cause product discoloration. If an internal coil system is preferable, low-pressure steam condensing inside horizontal nickel pencil coils is recommended. Pencil coils are used because of the ease with which they can be removed for inspection. Nickel is recommended primarily, because it contributes the least to color development

On large tanks, a vertical pencil coil projecting down from the tip of the tank is recommended. If the tank is completely frozen, the vertical unit is used to melt a hole through the frozen phenol to allow expansion of the hot liquid around the horizontal heater. The vertical coil should be installed with its lower end below the horizontal coils. The vertical coil is connected to a steam supply only during use and should be blown out with air following each use.

Agitation of phenol may be accomplished by a pump recirculation system.

Workers should never be permitted to enter an empty tank which has been used for phenol until it has been thoroughly cleaned and until the concentration of phenol in air is below the Threshold Limit Value of 5ppm.

A washing procedure may include thorough rinsing with warm or hot water, followed by a complete steaming for approximately 12hours and then another washing.

Pumps

Molten phenol can be transferred by pump or vacuum. For most phenol handling, centrifugal pumps with mechanical seals perform satisfactorily

The pump manufacturer can recommend the proper type of pump if the following parameters are known flow in gallons per minuet, the size and length of suction and discharge lines, the suction and discharge pressures, and the temperature of the phenol. A drain valve should be installed at the lowest point in the system so that the pump and all piping can be completely drained and washed before any maintenance work is done.

Totally enclosed fan cooled motors are recommended however, local fire and insurance codes should be consulted to determine if an explosion-proof motor must be used.

The following practices are recommended to minimize the possibility of pump leakage.

- Mechanical seals with appropriate safety devices such as double seals, flush glands or warning whistles are recommended.
- The pump shaft should be highly polished.
- Extra care should be exercised to get the best possible alignment between motor and pump to

insure seal life.

- The pump should be designed so that pump bearings will be able to carry thrust at no flow.
- If the bolts are removed from the suction and discharge flanges, the suction and discharge lines should remain in position. This test assures that the pump is not being strained by the lines.
- Pumps should not be subjected to forces or moments beyond specified pump tolerances.

Pipelines

The following are recommended practices in engineering pipelines for phenol.

1. Lines smaller than one inch should not be used.
2. A minimum of flanged connections should be used on phenol pipelines. Their use for connections to tanks, valves, pumps and other equipment is acceptable. Flanges used for connective piping should be avoided due to leak potential.
3. Phenol lines should never be buried because of the difficulty of checking for leakage, as well as the hazard involved in digging up a line surrounded by dirt soaked with phenol. All lines below grade should be in concrete troughs.
4. If overhead phenol lines cross walks or driveways, precautions must be taken to shield personnel from leaks and drips.
5. All lines carrying phenol should be sloped so that they can be completely drained for maintenance.
6. All newly installed phenol pipelines should be pressure tested by an approved method before insulation is applied.

Heat Tracing And Insulation

Heat traced lines, valves, and pumps are necessary to prevent phenol from freezing during handling. Phenol should be kept at 52℃ during transfer operations. If temperatures during transfer are over 60℃, discoloration is likely to occur.

Lines can be traced either by steam or electrical tracing. Steam tracing frequently involves tracing two-inch lines with 3/8-inch copper tubing covered by insulation adequate for existing temperature and wind conditions. Electrical tracing of lines with appropriate insulation may also be used, however, lines heat up more rapidly to the temperature required for phenol transfer operations when traced with steam.

Horizontal pipes are traced by running the tracing along the bottom of the pipe. Vertical lines are traced by running the tracing line along the pipe. The pipe and tracing are then covered with suitable insulation. If steam tracing is being used, a minimum of one steam trap should be used

for each tracer and every 150feet of tracing. Sixty to seventy-five psig steam is recommended in the tracing.

Hazard Information

Potential Health Effects

Eye : May cause severe irritation with corneal injury, which may result in permanent impairment of vision, even blindness.

Skin : Short single exposure may cause skin burns. Phenol is absorbed rapidly through the skin in amounts which could cause death. Signs and symptoms of excessive exposure may appear as effects in the central nervous system.

Ingestion : Single dose oral toxicity is considered to be moderate. Small amounts swallowed incidental to normal handling operations may cause serious injury; swallowing amounts larger than that may cause death. May cause severe burns of the mouth and throat.

Inhalation : A single prolonged(hours) excessive inhalation exposure may cause adverse effects. Vapors or mists may cause irritation of the upper respiratory tract(nose and throat) and lungs. Signs and symptoms of excessive exposure may be central nervous system effects.

Systemic (Other Target Organ)
Effects : Repeated excessive exposure may cause central nervous system effects (including respiratory, motor difficulties and paralysis) digestive disturbances, liver and kidney effects.

Cancer Information : Did not cause cancer in laboratory animals.

Teratology (Birth Defects) : Phenol has been toxic to the fetus in laboratory animals at doses nontoxic to the mother. Birth defects (cleft palate) were seen in mice at maternally lethal doses. This is a common developmental abnormality in mice and is associated with stress to the maternal animals.

Reproductive Effects : In animal studies, phenol did not interfere with reproduction. Toxicity to the newborn animals was observed at doses that were toxic to the maternal animals.

Toxicity

Death may result from absorption of phenol through the skin, even from an area as small as the hand and forearm. Eye and skin contact also can produce severe and painful burns in a very short time.

Although contact with phenol is painful, phonol also acts as a local anesthetic, so the pain disappears in a short time even though the phenol is still present on the skin. Therefore, loss of pain cannot be relied upon as an indication that phenol has been completely removed from the skin.

Phenol is also readily absorbed by inhalation in acutely toxic amounts. Fumes are irritation to the eyes, nose, and skin. However, odor cannot be relied on as an adequate warning against overexposure.

Precautions For Safe Handling And Use

Users should :

1. Periodically obtain a current Material Safety Data Sheet (MSDS) on phenol and consult it for additional up to date information on physical properties, toxicity and handling recommendations.
2. Read and follow all current label directions and precautions.
3. Always wear chemical workers goggles, face shield, neoprene rubber gloves and protective clothing as protection against accidental contacts. When the possibility of contact with phenol is greater, additional personal protection such as neoprene rubber boots, neoprene rubber aprons, full slicker suits and respiratory protection should be worn.
4. Install and maintain safety showers and eye wash fountains near all locations where phenol is handled. Workers must have immediate access to this equipment.
5. Provide sufficient ventilation to maintain employee exposures to phenol vapors below 5ppm (vol/vol) on an eight-hour, time-weighted-average basis.
6. Wear respiratory protection in absence of proper environmental control. For emergencies, positive pressure breathing apparatus of full-face respirator is recommended
7. Use caution when handling phenol at elevated temperatures. Phenol presents no unusual fire hazard when handled at ambient temperature, but will burn if ignited or involved in a fire. The lower flammability limit for the vapor is 1.5% in air. Phenol will give off flammable toxic vapors at elevated temperatures.

Emergency Treatment

Skin Contact

In case of accidental contact with phenol, it is essential that all phenol be thoroughly removed from the skin in the shortest time possible.

- **Immediately** begin a thorough washing with large volumes of water. Continue for at least 30 minutes. The phenol odor will begin to disappear as it is successfully washed away. **Remember, phenol is a local anesthetic. Loss of pain does not indicate phenol has been removed from the skin.**
- **Immediately** remove all clothing.
- **Call** a physician immediately.
- Thoroughly wash contaminated clothing before reuse or discard. Destroy contaminated leather articles such as shoes, belts, watchband, etc.
- **Clean** contaminated equipment immediately or discard.

Eye Contact

- **Flush** eyes immediately and continuously with plenty of flowing water for at least 30 minutes.
- **Call** a physician immediately.

Inhalation

- **Remove** the affected person immediately from the contaminated area to fresh air.
- **Call** a physician at once or transport to a medical facility.
- If breathing stops, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel.

Ingestion

- Phenol is highly toxic by ingestion. If swallowed, do not induce vomiting. Give the affected person large amounts of milk or water if available.
- Call a physician immediately
- Never give anything by mouth to an unconscious person. Contact medical personnel.

A physician should always be called immediately to care for any person who has been in contact with phenol. Victims must rest immediately after receiving emergency care. Rest after exposure to phenol is important and should be enforced whether burns are present or not.

Environmental Considerations

Spills

Make sure to use appropriate safety equipment and clothing (see “Precautions for Safe Handling and Use,”). Contain and isolate the spill. Thoroughly ventilate area. Allow small spills to solidify, then scoop into steel containers. Dike larger spills and recover into steel containers. Dispose of steel containers in compliance with local, stat and federal requirements under the Resource Conservation and Recovery Act.

Flush the spill area with large quantities of water until all visible traces and odors have disappeared. Recover the water and dispose of properly.

Disposal Of Liquid Wastes

It is often necessary to install a waste disposal system when using phenol, because of the toxicity and taste of extremely low concentrations of phenol in water. Concentrations of phenol in water. Concentrations of phenol, as low as 10ppm, are toxic to the fish and aquatic life and even lower concentrations cause taste in water supplies.

Chlorination of the phenol in water supplies greatly magnifies the taste problems. A number of different methods of destroying or concentrating phenolic wastes have been developed.