Lutropur® – the friendly acid

The purest form of MSA methanesulfonic acid made by BASF

BASF
The Chemical Company

Lutropur® MSA –

High-purity Methanesulfonic Acid from BASF

Highly effective, efficient and economical: that is probably the best way to describe Lutropur MSA – high purity methanesulfonic acid (MSA) from BASF.

Because of its unique property profile, methanesulfonic acid is becoming increasingly important. In numerous different applications and industries, ranging from chemical synthesis and metal surface treatment through to industrial cleaning, Lutropur MSA is helping our customers to be more successful.

Lutropur MSA is ideal for the manufacture of sustainable products. With Lutropur MSA it is often possible to meet more stringent environmental and safety requirements than with other acids.

If Lutropur MSA helps ...

- to achieve optimum industrial results
- to comply with rules and regulations
- to cut costs

... it's because at BASF, we create chemistry.

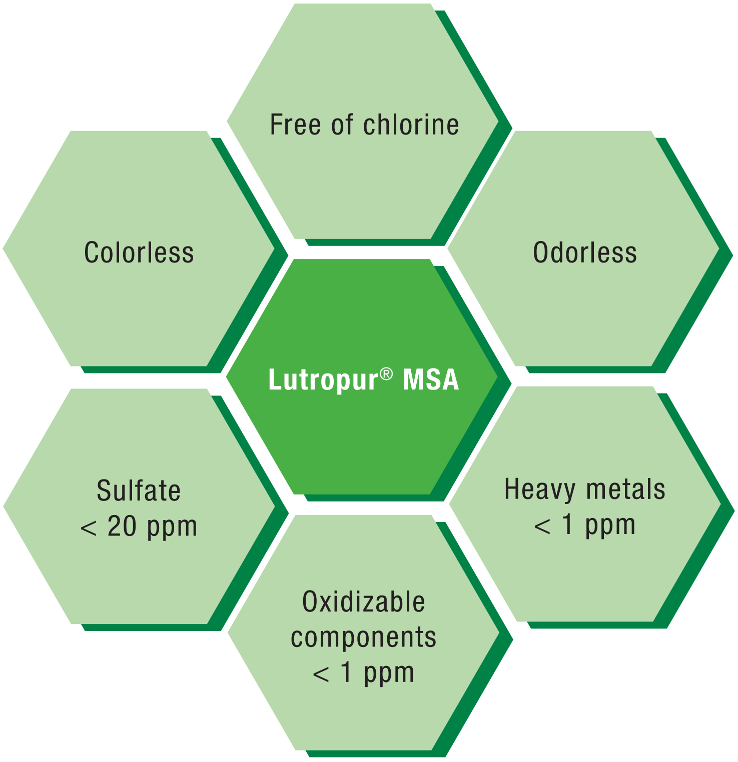
Contents

1. Product and Quality

Lutropur MSA is pure methanesulfonic acid. Methanesulfonic acid (MSA) is a strong and odorless organic acid with a unique property profile that distinguishes it from all other acids.

Benefits in practical applications come, for example, from its nonoxidizing nature, the high solubility of its salts, the absence of color and odor, and the fact that it is readily biodegradable. Consequently, MSA is becoming increasingly important in a number of applications and industries.

Using a unique manufacturing process, BASF is able to provide a colorless and odorless product that is virtually free of metal ions and sulfates. Chlorine-containing by-products are also ruled out by the halogen-free process. As a result, consumers in all relevant fields benefit from being able to use MSA that is of very high purity.



MSA is supplied by BASF as a 70% aqueous solution under the brand name Lutropur MSA. Anhydrous MSA is available under the brand name Lutropur MSA 100.

Typical values	**Lutropur MSA**	**Lutropur MSA 100**
Concentration [wt.%]	70.0	> 99.8
Sulfate [ppm]	< 20	< 30
Total chlorine (incl. Cl^-) [ppm]	< 1	< 1
Oxidizable constituents [ppm]	< 1	< 1
APHA color value	< 5	< 20
Heavy metal content [ppm][1]	< 1	< 1

[1] The total concentration of the following metals is less than 1 ppm: Ag, Al, As, Ba, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, Li, Mg, Mn, Mo, Ni, Pb, Sb, Se, Sn, Ti, V, Zn, Zr.

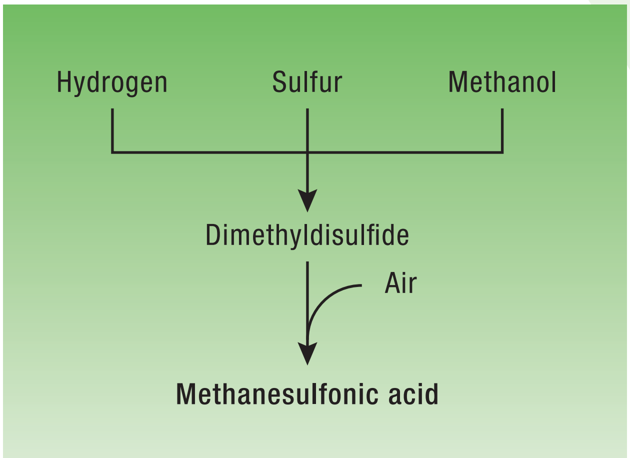
® = Registered trademark of BASF group

2. Manufacturing Process

In the manufacturing process developed and patented by BASF, sulfur, hydrogen and methanol are first converted into the intermediate product dimethyldisulfide (DMDS). The DMDS is refined by distillation and then catalytically oxidized with atmospheric oxygen to form methanesulfonic acid and water. A final distillation step ensures the unique purity of Lutropur MSA.

Both BASF's original production facility in Ludwigshafen, Germany (commissioned in 2003, annual capacity 10,000 metric tons) and the extension (to be commissioned in 2012, annual capacity 20,000 metric tons) operate according to this process. With a total annual manufacturing capacity of 30,000 metric tons, BASF is the world's leading supplier of methanesulfonic acid.

The advantages of this process are that it is very safe and reliable, the raw materials are readily available, the whole process is free of chlorine, and it fits very well into the integrated production complex in Ludwigshafen. This continuous process also ensures consistently high product quality.



Innovative technology for producing high-purity methanesulfonic acid – Lutropur MSA is manufactured in a plant that is an integral part of the Ludwigshafen production complex.

3. Properties

MSA combines a number of beneficial physical and chemical properties. These properties make MSA the reagent of choice in many different applications. MSA is a strong organic acid with no oxidizing properties. Its high thermal stability compared with aromatic sulfonic acids is particularly useful in the synthesis of chemicals. One of the reasons why MSA is so widely used in the electronics industry is that the salts that it forms with metals are highly soluble. Many organic salts of methanesulfonic acid also exhibit very good solubility properties. Especially methanesulfonates of heterocyclic nitrogen compounds often have a low melting point and are used as ionic liquids.

Other advantages from the ecological point of view are its ready biodegradability and its low carbon content (TOC). With a melting point of –54°C, Lutropur MSA can be handled in the form of a liquid over a wide temperature range. Being odorless, Lutropur MSA can also be used in odor-sensitive applications and processors have a free choice when it comes to modifying the odor of their formulations.

On the boundary between organic and inorganic chemistry

With many of its properties, methanesulfonic acid is on the boundary between organic and inorganic chemistry. For example:

- **Distribution between organic and inorganic phase**
  This plays a role in catalysis: MSA works better in an organic phase and can be washed out more easily than inorganic acids. Organic incrustations can also be removed more easily in cleaning processes.

- **Acid strength:** the acid strength of MSA is between that of carboxylic acids and that of strong mineral acids.

The most important properties for an acid, namely acid strength, odor and solubility of salts, are examined in more detail below. The toxicological and ecological aspects are covered in Chapter 4. A summary of the properties by comparison with other acids can be found in Chapter 7.

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Lutropur MSA

- strong organic acid
- nonoxidizing
- easy to handle
- high thermal stability
- low vapor pressure
- no toxic fumes
- low carbon content (TOC)
- odorless
- colorless
- readily biodegradable
- hardly any contribution to COD
- free of nitrogen, phosphorus and halogens
- resistant to hydrolysis

3.1 Physical properties

Typical values	Lutropur MSA	Lutropur MSA 100
Appearance (23°C)	clear, colorless liquid	
Melting point [°C]	–54	19
Odor	without	
Vapor pressure at 23°C [hPa]	4	0.001
Density [g/cm³]	1.35	1.48
Kinematic viscosity mpas [mm²/s]	8.2	8.3
Boiling point [°C]	>100 (1,013 hPa)	168 (10 hPa)
Solubility in g MSA/l		
water	miscible in all proportions	
ethanol	miscible in all proportions	
tetrahydrofuran	miscible in all proportions	
dimethylsulfoxide	miscible in all proportions	
toluene	68	
n-hexane	12	

No odor

Lutropur MSA is odorless. Because the intensity of the odor is governed primarily by the vapor pressure of a compound, vapor pressure curves provide an indication of the odor intensity of a substance. Figure 1 shows the vapor pressure of hydrochloric acid, sulfuric acid, formic acid, acetic acid and methanesulfonic acid as a function of temperature. The curves show that compounds with a strong odor, such as hydrochloric acid, acetic acid and formic acid, have a high vapor pressure, as would be expected. By contrast, methanesulfonic acid is characterized by an extremely low vapor pressure, which is consistent with its lack of odor.

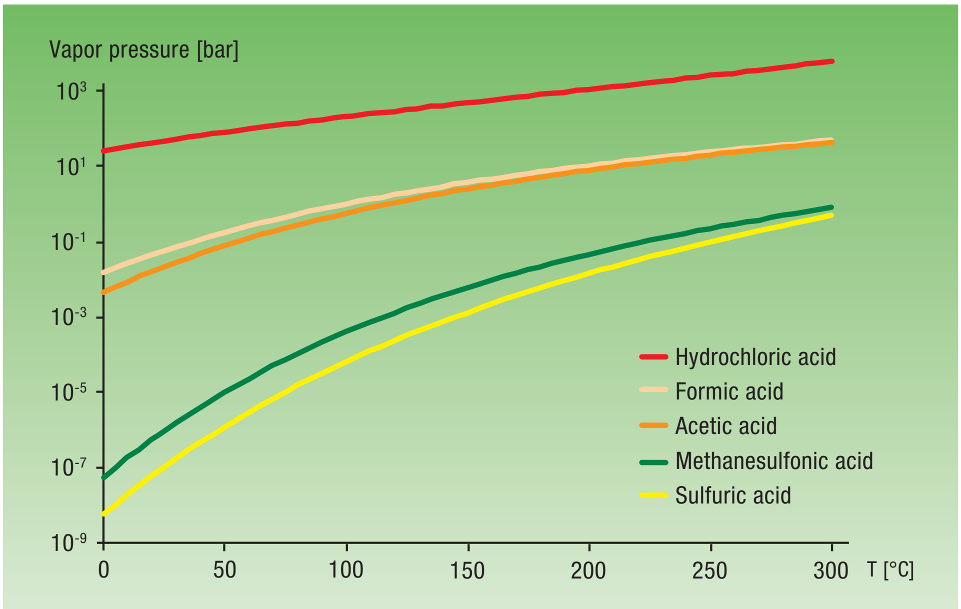


Figure 1:
Vapor pressure curves for selected acids.

The absence of any odor means greater safety at the workplace, as there are no acrid vapors. Formulators have more freedom to control the odor of their products if they use MSA, which does not have any inherent odor to interfere with it. As a result, MSA is preferred for use especially in high-temperature processes, e.g. in pickling baths, process cleaning solutions or the production of biodiesel, because it can be handled safely.

Methanesulfonic acid is hygroscopic (cf. Chapter 6 Storage). This property becomes more pronounced as its concentration increases, and this is put to use in industrial applications. For example, with Eaton's reagent (7.5% P_2O_5 dissolved in MSA), water can be separated off from organic compounds without these compounds being oxidized. [4]

3.2 Chemical properties

3.2 a. Acid properties – the anion makes all the difference

The strength of acids has a wide-ranging influence on the rate at which they react. For example, when limestone is dissolved, the protons present in the acid solution react with the insoluble calcium carbonate to form carbon dioxide, water and the soluble calcium salt of the acid being used (Figure 2). Therefore, the more protons, i.e. active species, the acid used is able to supply, the greater the efficiency of the dissolving process.

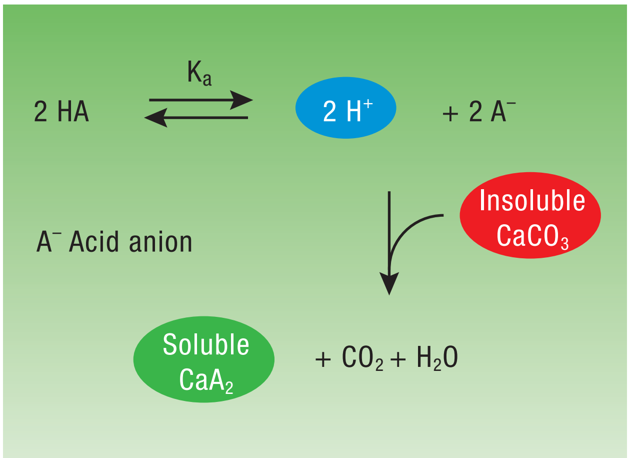


Figure 2: Dissolving $CaCO_3$

Acid strength is defined and calculated with the help of the law of mass action. The acidity constant K_a is obtained by applying the law of mass action to the proton transfer reaction: the higher the figure for this equilibrium constant, the stronger the acid. Figure 3 shows the equilibrium constants K_a of various acids on a logarithmic scale. It can be seen from the comparison that hydrochloric acid, sulfuric acid and methanesulfonic acid are much stronger acids than, for example, acetic acid, formic acid, citric acid, phosphoric acid and amidosulfonic acid.

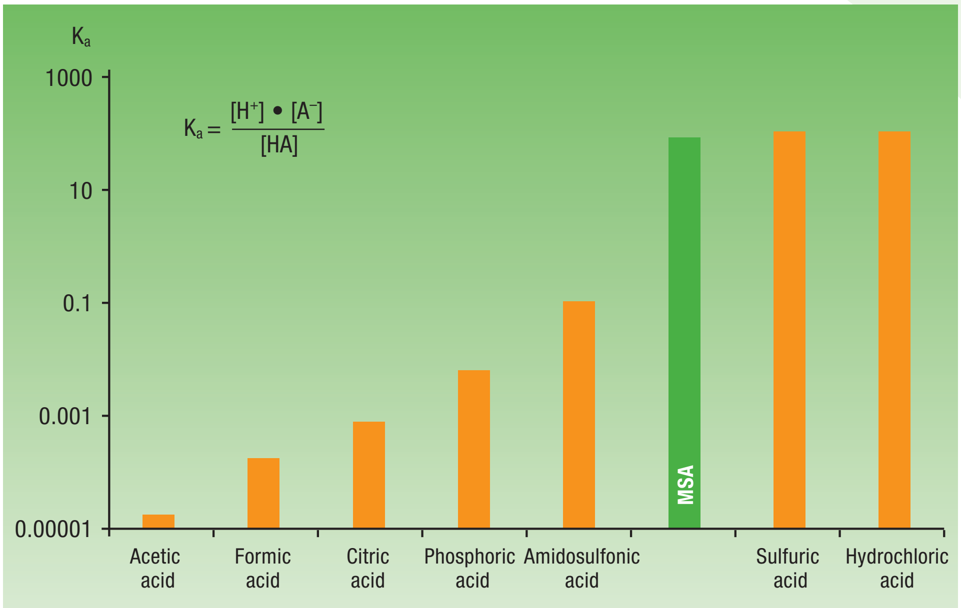


Figure 3:
Equilibrium constants K_a of selected acids.

From the acidity constants, together with the law of mass action, it is possible to calculate the number of protons that are obtained from 1 mol of each acid. For instance, 1 mol of citric acid donates only 50 mmol of protons, acetic acid donates as little as 4 mmol of protons and even amidosulfonic acid only donates 270 mmol, whereas 1 mol of hydrochloric acid or methanesulfonic acid releases 1 mol of protons – i.e. active species – in aqueous solution (Table 1). This means that a lower molar concentration of methanesulfonic acid is needed to release a certain number of protons than would be required if acetic acid, formic acid, phosphoric acid or amidosulfonic acid were used. Normally, users are more interested in the required mass concentration of the acid than in the molar concentration. If acids are to be compared on the basis of their mass concentrations, attention must be given not only to the acid strength, but also to the molecular weight.

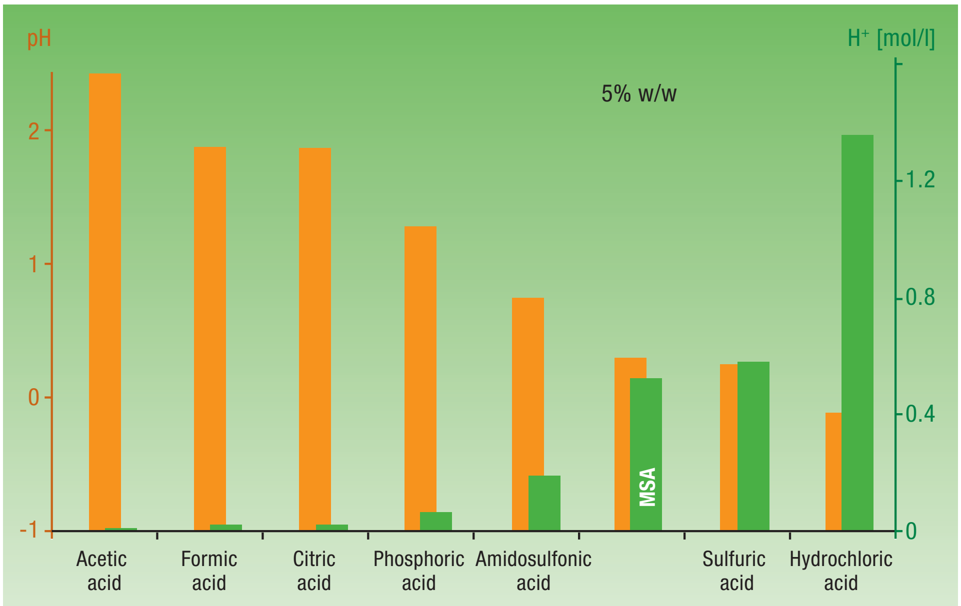
Table 1:
Protons released by 1 mol of acid.

1000 mmol ...	**releases**
Acetic acid	4
Formic acid	10
Citric acid	50
Phosphoric acid	80
Amidosulfonic acid	270
Methanesulfonic acid	**1000**
Hydrochloric acid	1000
Sulfuric acid	1095
	mmol H^+

3. Properties

The molecular weight and the acid dissociation constant can be used to calculate the number of protons that are released from solutions with the same mass concentration. Figure 4 shows the concentrations of protons in 5% aqueous solutions of common acids. It can be seen from the diagram that only hydrochloric acid and sulfuric acid release more protons than methanesulfonic acid at a concentration of 5%. All the other acids – acetic acid, formic acid, citric acid, phosphoric acid and amidosulfonic acid – provide far fewer protons at this concentration. Conversely, this means, of course, that considerably less methanesulfonic acid than acetic acid, formic acid, citric acid, phosphoric acid or amidosulfonic acid needs to be used to obtain a certain concentration of protons (a certain pH value).

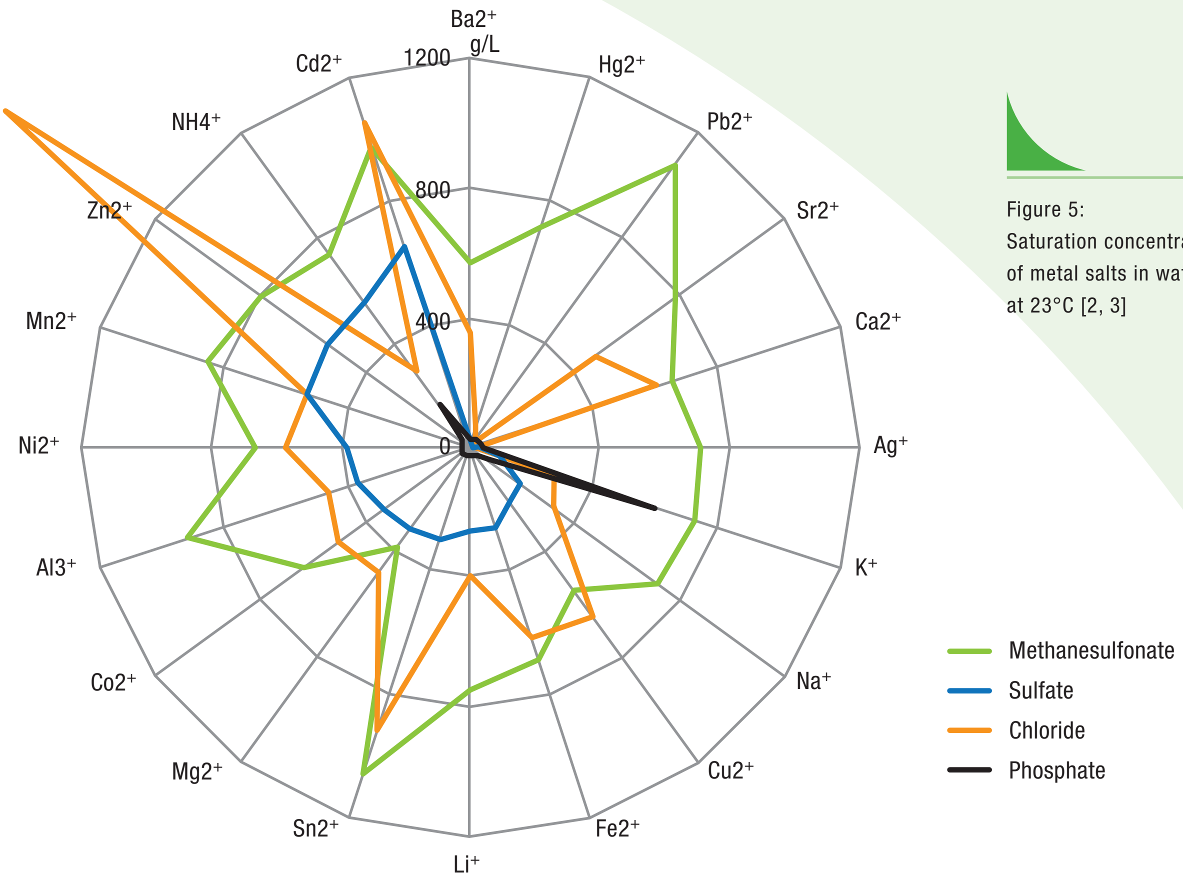
Figure 4:
Proton concentration and pH of 5% acids.



3.2 b. Dissolving power

To be efficient, processes often require the reaction products (salts) produced in the process to have a high level of solubility. Otherwise, these salts give rise to deposits, which usually hamper processes. Looking at the solubilities, one can see that the salts of methanesulfonic acid have very high solubility levels.

They even dissolve more readily than many chlorides. By contrast, the corresponding sulfates and, especially, phosphates are only very sparingly soluble. The methanesulfonates of metals such as barium, calcium, strontium, magnesium and manganese that are formed when common precipitates are dissolved are highly soluble in water. Thus, methanesulfonic acid is able to keep metallic and nonmetallic cations in solution in the form of the corresponding sulfonates without any problem – even under neutral pH conditions.



Cations arranged according to increasing solubility of sulfates

Figure 5:
Saturation concentration
of metal salts in water in g/L
at 23°C [2, 3]

Table 2:
Comparison of the solubility of metal salts in water; saturation concentrations in g/L at 23°C. [2, 3]

	Methanesulfonate	Sulfate	Chloride	Phosphate
Ag^{+}	713	9	0	0
Al^{3+}	913	363	450	0
Ba^{2+}	567	0	356	0
Ca^{2+}	656	3	611	0
Cd^{2+}	975	646	1048	0
Co^{2+}	630	335	502	0
Cu^{2+}	546	215	655	0
Fe^{2+}	690	266	626	0
Fe^{3+}	502	440	919	0
Hg^{2+}	707	0	65	0
K^{+}	736	109	288	600
Li^{+}	749	269	397	1
Mg^{2+}	378	317	478	0
Mn^{2+}	849	532	518	0
Na^{+}	716	197	326	23
NH^{4+}	737	540	271	45
Ni^{2+}	665	378	568	0
Pb^{2+}	1075	0	9	0
Sn^{2+}	1066	305	931	0
Sr^{2+}	782	0	482	0
Zn^{2+}	792	536	1772	0

Cation	Solubility [g/L]
Bi^{3+}	473
Ce^{3+}	1131
Ce^{4+}	976
Cs^{+}	1340
Dy^{3+}	1573
Er^{3+}	1453
La^{3+}	1110
Nd^{3+}	1069
Pr^{3+}	1089
Rb^{+}	1079
Sm^{3+}	1165
Y^{3+}	1453
Yb^{3+}	972
Hydroxylammonium	722
Propylammonium	867
Dicyclohexylammonium	845

Table 3:
Solubility of other metal methanesulfonates in water at 23°C, saturation concentration in g/L [3]

Many other salts of MSA, including rare-earth salts and compounds with nitrogenous bases, also have a remarkably high solubility (cf. Table 3).

Because of the excellent solubility of the organic and inorganic methanesulfonates, methanesulfonic acid is used in applications where this feature, combined with the other beneficial properties of MSA, provides crucial advantages:

- all types of acid cleaning processes
- electroplating
- neutralization of active chemical and pharmaceutical ingredients
- extractive metallurgy and mining
- metal recycling
- dissolving of rock
- industrial washing processes
- ionic liquids

3.2 c. Redox stability

MSA is very resistant to strong oxidizing agents. For example, it does not react, in the presence of hydrogen peroxide, nitric acid or permanganate. This means, amongst other things, that MSA can be used in formulations that contain such oxidizing agents. Even in hot chromosulfuric acid, MSA is relatively stable. This is also evident in the determination of the COD value, which, at about 4 mg O_2/g COD, is equivalent to only about 2% of the amount of oxygen required theoretically for complete oxidation [6].

MSA is also resistant to strong reducing agents, such as nascent hydrogen.

In the cyclic voltammogram this high redox stability can also be seen in the electrochemical stability of MSA. MSA is stable over a remarkably wide range. At about 3.8 volt, the electrochemical window (ECW) of stability is very wide (cf. Figure 6).

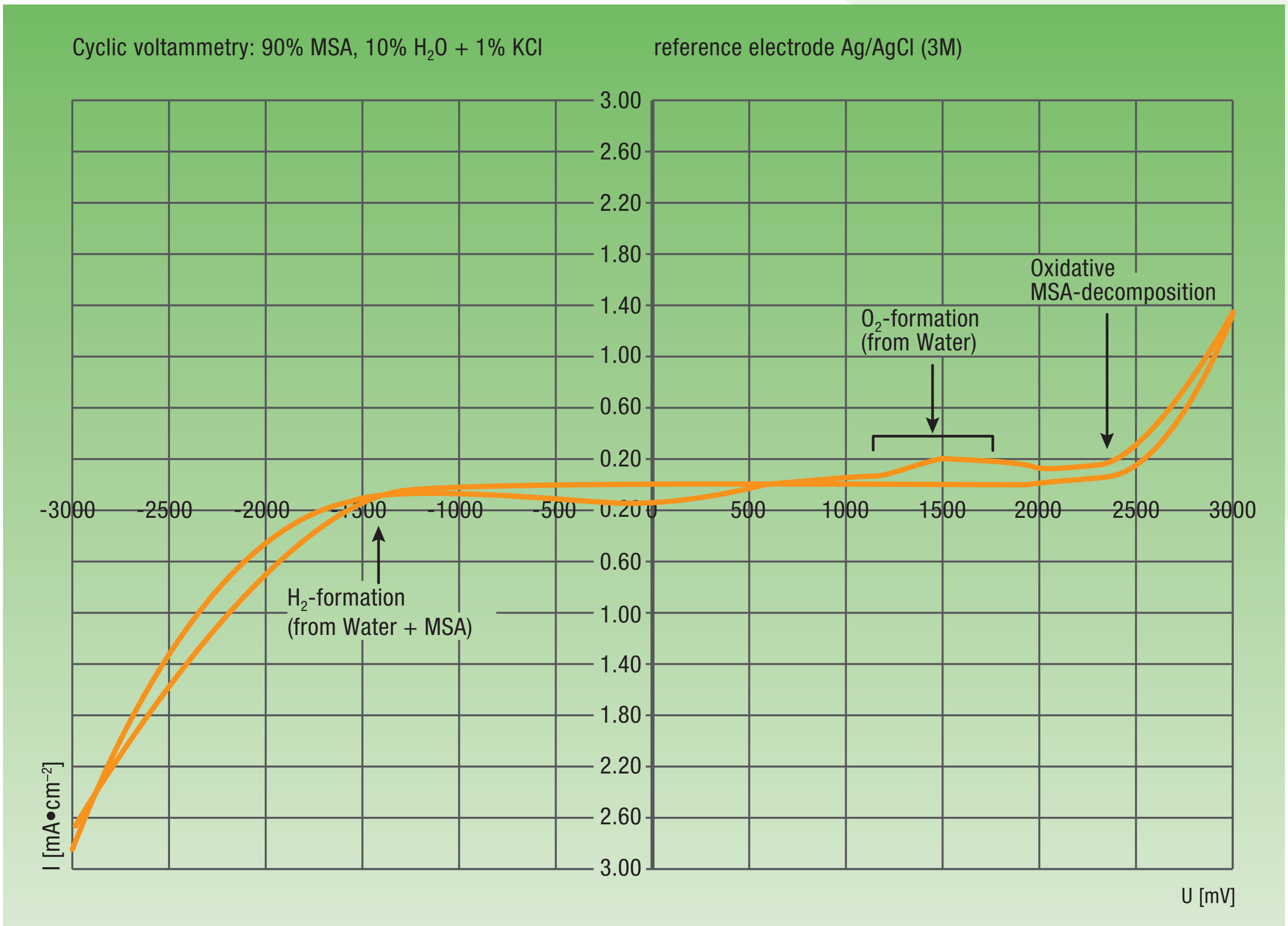


Figure 6:
Electrochemical window of MSA

3.2 d. Further chemical properties

Not only the redox stability of MSA, but its high level of stability generally should be highlighted. Apart from the formation of salts, MSA hardly reacts chemically with anything and is therefore practically inert. That also means that, under practical conditions, no unwanted secondary reactions take place.

MSA

- is not subject to hydrolysis
- does not undergo addition reactions
- does not undergo substitution reactions
- is stable in air to 180°C

4. Ecological and Toxicological Aspects

Eco-tox profile

- readily biodegradable
- virtually VOC free
- low TOC
- hardly any contribution to COD
- free of nitrogen
- free of phosphorus
- free of halogens

Methanesulfonic acid is readily biodegradable according to OECD Guideline 301 A, forming carbon dioxide, sulfate, water and biomass as decomposition products. Of all the organic sulfonic acids, MSA is the best choice from the environmental point of view because its oxygen demand for degradation is lower than that of all other organic sulfonic acids. As a result of its high resistance to oxidation, the measured chemical oxygen demand (COD) is also well below the figure for e.g. readily oxidizable carboxylic acids such as acetic acid.

Because it contains no phosphorus, MSA, unlike phosphoric acid, does not contribute to eutrophication and the associated increase in algal growth in aquatic environments. It is free of halogens and nitrogen and has a low toxicological risk potential to complete its attractive property profile.

Methanesulfonic acid is formed as the result of the photochemical oxidation of dimethylsulfide in the atmosphere and is thus part of the natural sulfur cycle [5]. MSA also has a lower vapor pressure than other acids (cf. Chapter 3), which is a further advantage from the point of view of safety at work and environmental protection. Therefore – unlike carboxylic acids such as acetic acid or glycolic acid – it is virtually free of volatile organic compounds (VOC).

Further advice and information can be found in the safety data sheets for Lutropur MSA and Lutropur MSA 100.

5. Material Compatibility

Lutropur MSA from BASF is less corrosive than other grades of methanesulfonic acid that are available. [1]

Nonetheless, as with all strong acids, attention must be paid to the choice of suitable materials.

Corrosiveness depends to a large extent on parameters such as temperature and concentration. In general, it is reduced by the presence of substances such as surfactants, oils and amines, but may be increased by halogens such as chloride.

Suitable materials for use in conjunction with pure 70% methanesulfonic acid (Lutropur MSA) are:

- Polyethylene, Polypropylene
- Selected Palatal® grades (polyester, polystyrene resins)
- Teflon® (PTFE)
- Glylon® (modified PTFE)
- Glass, enamel, ceramics
- Tantalum, zirconium
- High-quality special steels such as
  - 1.4539 [904L; X1NiCrMoCu25-20-5]
  - 1.4571 [316Ti; X6CrNiMoTi17-12-2]
  - 1.4591 [Alloy 33; X1CrNiMoCuN33-32-1),

For use with anhydrous methanesulfonic acid (Lutropur MSA 100) we recommend the following materials:

- Polyethylene, Polypropylene
- Teflon (PTFE)
- Glylon (modified PTFE)
- Glass, enamel, ceramics
- Tantalum, zirconium

Compatibility tests are advisable if these materials will be in contact with methanesulfonic acid for long periods.

Compared with other strong acids, methanesulfonic acid is not so corrosive: if similar quantities are used, the surface removal rates of MSA are normally many times less than those of sulfuric acid or hydrochloric acid. Because of the low vapor pressure, under normal conditions, there is no gas phase corrosion with MSA – by contrast with, for example, hydrochloric, formic or nitric acid.

The corrosiveness of strong acids such as MSA can be reduced significantly by the use of suitable corrosion inhibitors. We would be happy to advise you on suitable inhibitors for your system.

Please get in touch with us if you have any questions concerning materials.

6. Storage and Stability

Provided the product is stored properly in its sealed original packaging, the shelf life is at least

- 24 months for Lutropur MSA
- 9 months for Lutropur MSA 100

Methanesulfonic acid is hygroscopic. Storage tanks and packing units must therefore be sealed tightly and filled with dry protective gas. Irrespective of the precise content of the concentrated acid solution, its concentration in an open container at 23°C and 55% relative humidity is about 49% (cf. Figure 7).

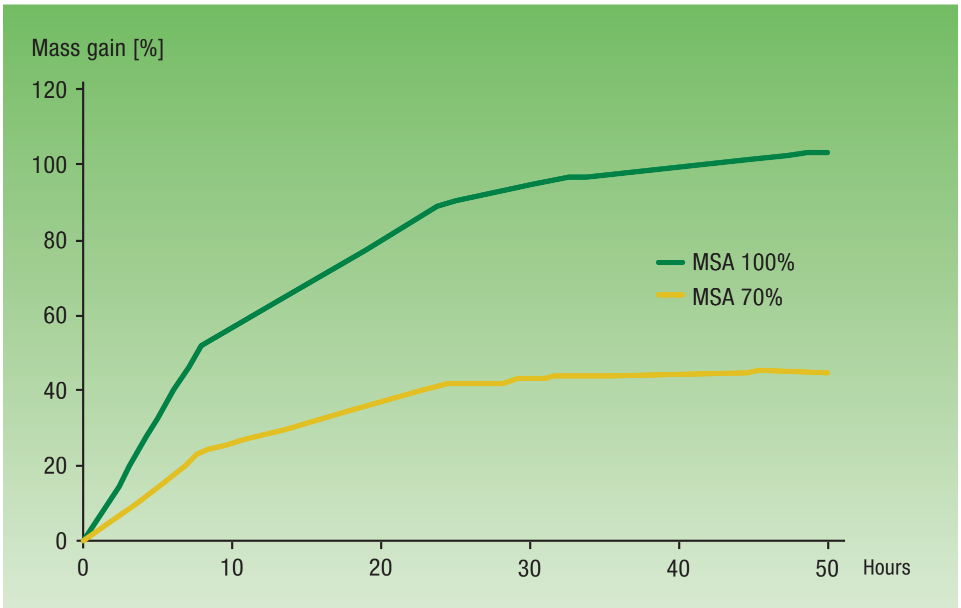


Figure 7:
Hygroscopic properties of MSA

When Lutropur, especially Lutropur MSA 100, is being taken out of containers, care must be taken to ensure that only stable materials are used and that no contamination (even in minute quantities) of the product takes place. Otherwise, the product may take on a dark color, though the properties in general will remain unaffected.

Name	**Methane-sulfonic acid**
Formula	**CH_3SO_3H**
Acid strength $pK_{S1,2,3}$	-1.9
Number of acid protons	1
Molar mass [g/mol]	96.107
COD [mg/g]	4
Solubility in water [g/L]	∞

Qualitative relative data

Vapor pressure	++
Odor	++
Corrosiveness	0
Reducibility	++
Resistance to oxidizing agents	++
Stability in aqueous medium	++
Solubility of salt	++
Temperature stability	++
Stability in storage	++
Biodegradability	++
TOC	0
VOC	++

7. Comparative Table of Acids

Sulfuric acid	Hydrochloric acid	Nitric acid	Phosphoric acid	Formic acid	Acetic acid	Citric acid	Sulfamic acid	p-toluenesulfonic acid	Glycolic acid	Fluoroboric acid	Oxalic acid
H_2SO_4	HCl	HNO_3	H_3PO_4	HCOOH	CH_3COOH	$C_6H_8O_7$	NH_2SO_3H	$C_7H_7SO_3H$	$C_2H_4O_3$	HBF_4	$C_2H_2O_4$
-3 +1.9	-6.0	-1.3	2.0 6.8 12.5	3.82	4.76	3.09 4.75 5.41	1.0	0.7	3.82	-0.4	1.23 4.19
2	1	1	1	1	1	2	1	1	1	1	2
98.08	36.461	63.013	97.995	46.026	60.053	192.125	97.095	172.205	76.052	87.813	90.036
na	na	na	na	414	1091	665	na	758	800	na	208
∞	485	∞	∞	∞	∞	605	147	700	1000	600	95
++	−−	0	++	−−	−−	++	++	++	+	++	++
++	−−	−	++	−−	−	++	0	++	+	++	++
−	−−	−	0	+	+	+	0	0	+	−−	0
0	++	−−	++	++	++	++	++	++	+	++	+
++	0	++	++	−−	0	−	0	+	−	+	+
++	++	++	++	++	++	++	−−	++	++	++	++
−−	++	++	−−	++	++	−	++	0	−	+	−−
++	−	−	++	0	+	0	+	0	+	−−	0
++	++	++	++	++	++	0	−−	+	+	+	++
na	na	na	na	++	++	++	na	−−	++	na	−
na	na	na	na	0	−	−−	na	−−	−	na	−
++	++	++	++	−−	−−	++	++	++	−−	++	−−

na = not applicable

++ very beneficial
\+ .
0 .
− .
−− unfavorable

8. Advantages

The unique property profile of MSA becomes especially evident in a direct comparison with other acids. The advantageous properties of MSA can be read off directly from the table. Reasons to choose MSA!

Lutropur MSA ...	Compared with ...
High solubility of its metal salts	sulfuric acid, phosphoric acid
Odorless	formic acid, acetic acid, hydrochloric acid
Chemically stable	amidosulfonic acid, glycolic acid
Nonoxidizing	nitric acid, sulfuric acid
Less corrosive	hydrochloric acid, sulfuric acid, nitric acid
Unlimited solubility in water	amidosulfonic acid
Virtually free of VOCs	formic acid, acetic acid, glycolic acid
Free of phosphorus	phosphoric acid
Free of nitrogen	nitric acid, amidosulfonic acid
Free of halogens	hydrochloric acid, tetrafluoroboric acid
Strong organic acid	formic acid, acetic acid, glycolic acid, citric acid
Easy to handle because liquid and odorless	amidosulfonic acid, citric acid, hydrochloric acid, formic acid

9. Literature

[1] – M. Finsgar, I. Milosev, Corrosion Science, 52 (2010) 2430 - 2438

[2] – T. Trella, Synthese und Charakterisierung von Methansulfonaten, Diploma degree, 2010, Heinrich Heine Universität Düsseldorf

[3] – M. D. Gernon, M. Wu, T. Buszta, P. Janney, Environmental benefits of methanesulfonic acid, Green Chemistry 1 (1999) 127-140

[4] – P. E. Eaton, G. R. Carlson, J. T. Lee, J. Org. Chem. 38 (1973), 4071

[5] – S. C. Baker, D. P. Kelly, J. C. Murrell, Nature 350 (1991) 627

[6] – W. Janicke, Chemische Oxidierbarkeit organischer Wasserinhaltsstoffe, Dietrich Reimer Verlag, Berlin 1983 (WaBoLu-Berichte 1/1983)

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Safety
We know of no ill effects that could have resulted from using our products for the purpose for which they are intended and from processing them in accordance with current practice. According to the experience we have gained up to now and other information at our disposal, our products do not exert any harmful effects on health, provided that they are used properly, due attention is given to the precautions necessary for handling chemicals, and the information and advice given in our safety data sheet are observed.

Labeling
Details about the classification and labeling of our products and further advice on safe handling are contained in the current safety data sheets.

Note
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08_101201e-01 03.2012 supersedes edition 08_101201e-00 dated 03.2011

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