Ashland™ carbomers

Essential rheology modifiers for personal care formulating

ASHLAND®
With good chemistry great things happen.™

Description

Carbomers are a range of polymers which are used in a wide range of personal care products as thickeners. They are:

- cross-linked polyacrylic acid polymers of high molecular weight.
- extremely efficient thickeners and powerful stabilizers at low concentrations in water and aqueous ethanol.
- anionic in nature and acidic in their unneutralized state and have to be neutralized with an appropriate base to achieve their thickening ability.
- effective across a wide pH range of 5 to 10.

Typical Uses of Carbomers

1. **As a stabilizer and rheology modifier in oil-in-water emulsions, Ashland carbomer:**
   - Provides a stable emulsion at low concentration, due to high yield value (prevents coalescence).
   - Aids spreadability on skin due to its electrolyte sensitivity.

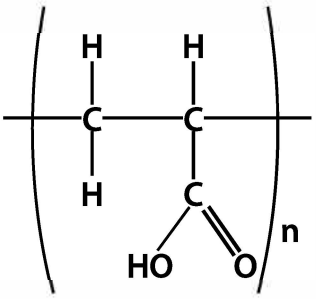
2. **As a gelling agent for aqueous-based gels such as styling gels, Ashland carbomer:**
   - Is efficient at low concentrations.
   - Provides a transparent gel.
   - Is compatible with other materials used in styling gels.
   - Is easy to incorporate into finished products.

3. **As a gelling agent for hydro-alcoholic gels such as hand sanitizers, Ashland carbomer:**
   - Has good solubility in aqueous alcohol.
   - Provides transparent gels with good skin feel and slip.
   - Is effective at low concentrations.

4. **As a stabilizer and rheology modifier in mixed multiphase surfactant systems such as conditioning shampoos and body washes, Ashland carbomer:**
   - Stabilizes emulsions and dispersions of the dispersed phases that may be used, such as silicones, anti-microbials, anti-fungals, natural oils, physical sunscreen ingredients and beads.

Chemistry of Carbomer

1. **Structure**
The basic building block of carbomer is acrylic acid.



2. **Physical Form**
Supplied as a fine white powder, with a faint acetic odor.

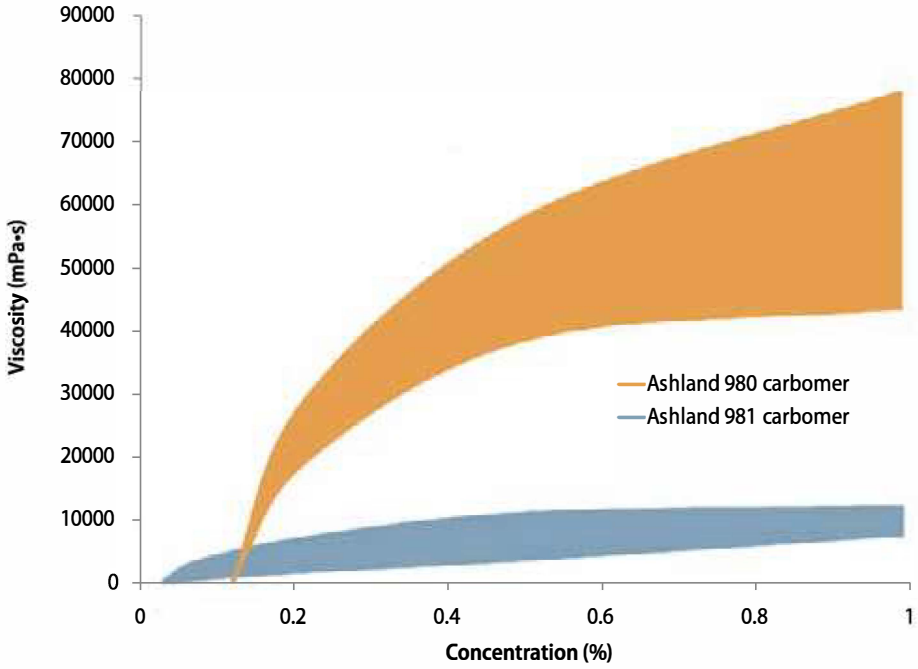
3. **Viscosity characteristics**
Carbomers exhibit pseudoplastic rheological behavior.

Polymer	Ashland 940 / 980 carbomers	Ashland 941 / 981 carbomers
Flow characteristics	Short	Long
Relative viscosity	High	Low
Ion tolerance	Low	Medium
Shear tolerance	High	Low

Effect of polymer concentration on viscosity:

Ashland carbomers are very efficient in thickening many personal care products. Fig 3.1 illustrates typical aqueous concentration vs. viscosity for Ashland carbomer at a pH of about 7.5.

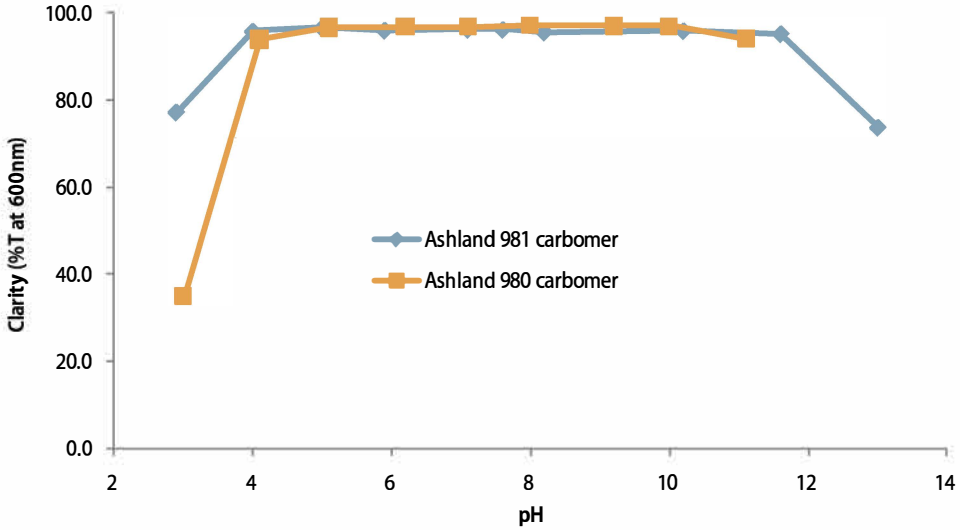
Ashland carbomer concentration vs. viscosity (Fig 3.1)



Effect of pH on viscosity and clarity

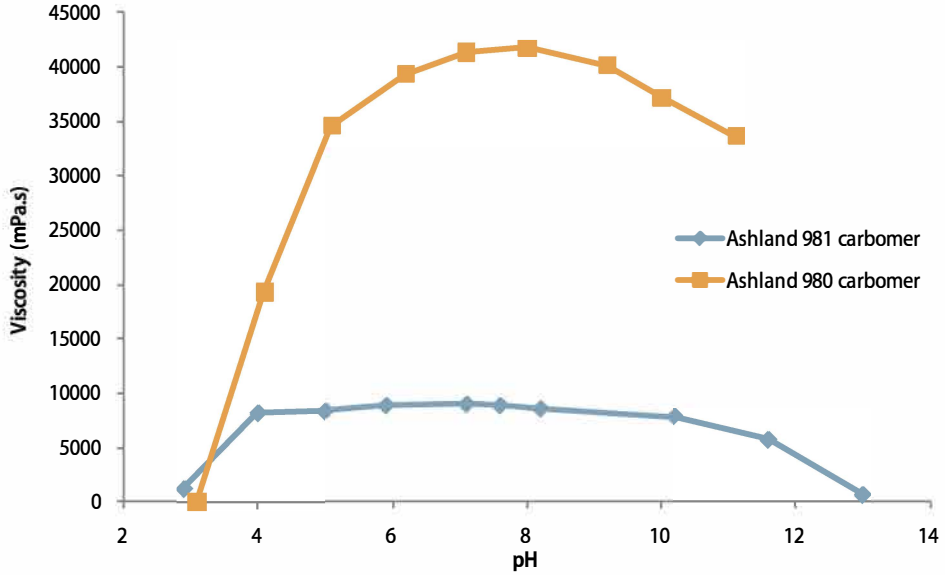
Personal care formulations are typically formulated at a mildly acidic to mildly alkaline pH, so it is important to understand how pH affects both the viscosity and the clarity of gels that are made with Ashland carbomers. Ashland carbomers retain excellent clarity between pH 4 and 10, as shown in Fig. 3.2.

Ashland carbomers clarity vs. pH (Fig 3.2)



Ashland carbomers' viscosity are stable across a pH range of 5 to 10. This is illustrated in Figure 3.3 for 0.5 weight percent concentration, reaching a viscosity maximum at pH values between 7 to 8. At pH above 10, the viscosity slowly decreases. At pH values below 5, viscosity is rapidly lost.

Ashland carbomer viscosity vs. pH (Fig 3.3)

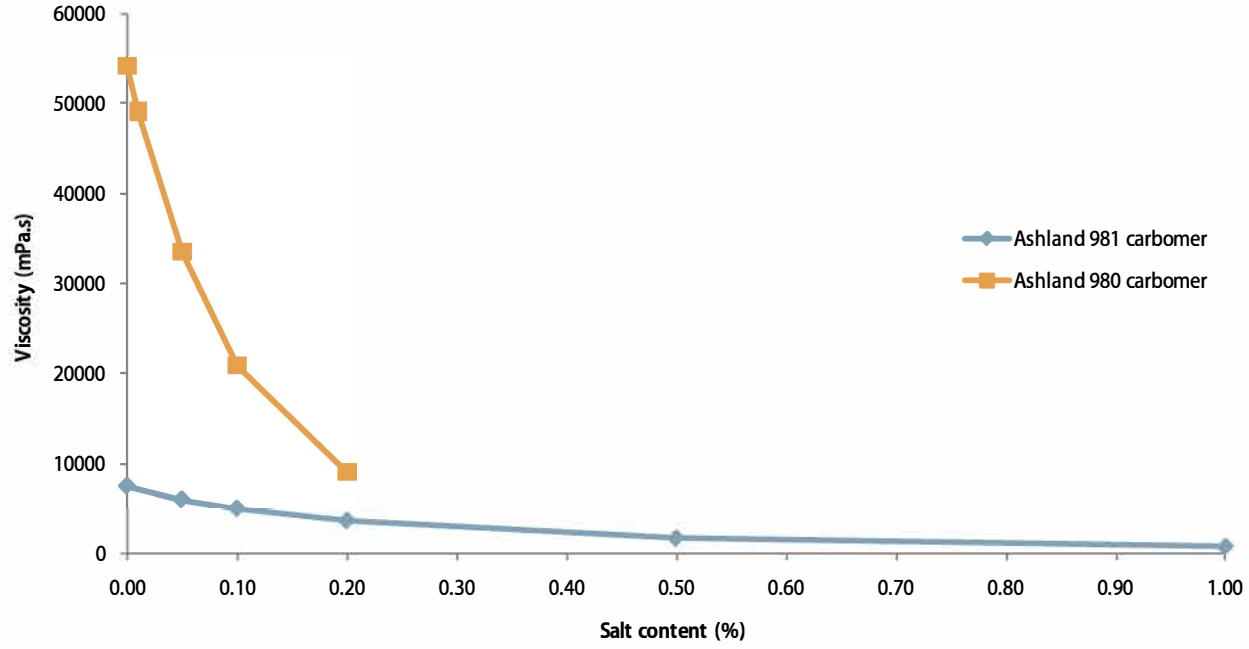


Effect of salt on viscosity and clarity of aqueous solution

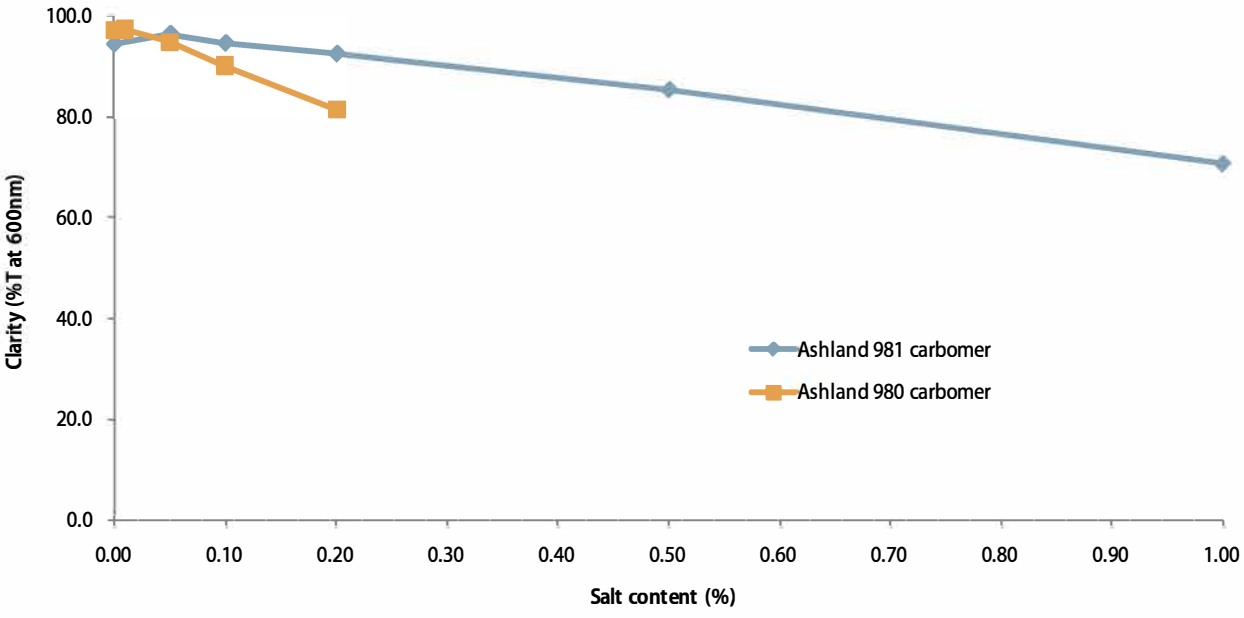
Addition of salt, such as sodium chloride, can have a significant effect on the viscosity of carbomer. Care should be taken when using any salt with carbomer-based systems. Addition of salt directly to the carbomer solution is not recommended. This needs to be taken into account when formulating surfactant-based systems where sodium chloride is either present in the surfactants or is used as an additional thickening agent. In skin care emulsions, the salt effect can be used to help initial spreadability of the product onto the skin upon application.

Addition of sodium chloride directly to the Ashland 980 carbomer aqueous solution reduces its solution viscosity. Ashland 981 carbomer is less sensitive to the presence of sodium chloride in formulation as can be seen by the very slow decrease in viscosity as the salt content is increased up to 1.0%, as shown in Fig. 3.4. Similarly, aqueous solution clarity is also affected by the salt concentration, as shown in Fig. 3.5.

Effect of salt (NaCl) on the viscosity of a 0.5% Ashland carbomer solutions (Fig 3.4)



Effect of salt (NaCl) on the clarity of a 0.5% Ashland carbomer solution (Fig 3.5)



Formulating with Ashland carbomers

Care must be taken in working with these materials in aqueous, non-aqueous and mixed solutions in order to prepare consistently reproducible results and to optimize their function.

Carbomers are highly hydrophilic and wet out very quickly when placed in water. Because their form is that of a fine powder they tend to aggregate and form clumps which become difficult to disperse. However, this can be avoided with proper care in dispersing and wetting out of the polymer.

Once it is properly dispersed and wetted out, carbomer needs to be neutralized with a base to activate the thickening. It is usually neutralized to a pH of 6 to 8 for optimum viscosity efficiency. Some formulations may require slightly broader ranges.

There are a number of bases that can be used and the choice of base will depend on the type of formulation. Bases used included sodium hydroxide, ammonia, potassium hydroxide, aminomethyl propanol and triethanolamine.

The amount required to neutralize varies depending on:

- the type of neutralizing agent,
- the strength of the solution, and
- the formulation.

Addition of the neutralizing agent to the formulation can be done at varying stages of the process and again this is dependent upon the formulation and the process being used.

Dispersion and Dissolution Techniques:

1. Addition to aqueous solutions

Ashland carbomers should be added very slowly into rapidly agitating water; ideally it should be the first component of the formulation ingredient added into the water. Any method of slow sifting or mechanical equipment such as an eductor which allows controlled addition should be considered for production-scale batches.

For small size batches, stirrers should be used at a speed of 800 to 1000 rpm.

The mixing should continue until all particles have been dispersed, usually about 10 to 15 minutes for lab-scale batches. The solution will be hazy at this time.

At this stage, neutralization can be done unless there is a large portion of other aqueous ingredients (such as surfactants) which should be first added and mixed thoroughly before neutralization.

Care should be taken to avoid entrapping any air into the mix and high shear mixers such as Lightning Mixers should be avoided.

2. Addition into emulsions

The carbomer can be dispersed into the oil phase (which can include melted waxes and oils). It should be added slowly while mixing until a smooth homogenous dispersion is obtained.

The oil phase containing the carbomer can then be added with moderate agitation into the water phase containing the neutralizing agent.

The solution should then be mixed until a smooth emulsion is observed.

3. Addition to hydro-alcoholic solutions

The carbomer should be added in either the water or the water and alcohol blend. Good mixing is required with high agitation. Mix until the dispersion is smooth and lump free.

The balance of alcohol should then be added followed by any other ingredients while slowly stirring the mix.

Finally, add the neutralizing agent as quickly as possible as thickening is almost instant and then mix slowly to avoid aeration.

Products

Typical properties, Ashland carbomers:

Form	Fine white powder
Color	White
Odor	Faint acetic odor

	Ashland 980 carbomer	Ashland 981 carbomer
Brookfield viscosity (25°C, 0.05% aqueous gel neutralized)		700 - 3,000 cps
Brookfield viscosity (25°C, 0.2% aqueous gel neutralized)	13,000 – 30,000 cps	2,000 - 7,000 cps
Brookfield viscosity (25°C, 0.5% aqueous gel neutralized)	40,000 – 60,000 cps	4,000 - 11,000 cps

	Ashland 940 carbomer	Ashland 941 carbomer
Brookfield viscosity (25°C, 0.05% aqueous gel neutralized)		700 - 3,000 cps
Brookfield viscosity (25°C, 0.2% aqueous gel neutralized)	19,000 – 35,000 cps	1,950 - 7,000 cps
Brookfield viscosity (25°C, 0.5% aqueous gel neutralized)	40,000 – 60,000 cps	4,000 - 11,000 cps

Residual Solvents

Ashland 980 and 981 carbomer– Processed in ethyl acetate and cyclohexane (residual of ethyl acetate and cyclohexane of ≤ 0.45 combined percent)

Ashland 940 and 941 carbomer– Processed in benzene (residual of ≤ 0.50 percent)

Guideline formulations

Styling Gel

Ingredient (INCI name)	Ingredient (trade name)	% w/w
Part 1		
Deionized (DI) water		58.90
Carbomer	Ashland 980	0.50
Part 2		
Deionized water		36.00
Sorbitol, 70%	Neosorb* 70/70B	1.00
Polyvinylpyrrolidone	ISP* PVP K30	2.50
Triethanolamine		0.50
Phenoxyethanol and Ethylhexylglycerin	Euxyl* PE 9010	0.60

Procedure

1. Disperse Ashland 980 carbomer in DI water with vigorous mixing.
2. Add sorbitol, PVP K30 and Euxyl* PE 9010 and mix until uniform.
3. Add all triethanolamine quickly into mix and then mix slowly to avoid further aeration.

Hand Sanitizer

Ingredient (INCI name)	Ingredient (trade name)	% w/w
Deionized water		34.65
Carbomer	Ashland 980	0.25
Ethanol		65.00
Aminomethyl Propanol	AMP Ultra PC	0.10

Procedure

1. Disperse Ashland 980 carbomer in DI water as described above.
2. Add ethanol and mix until uniform.
3. Add aminomethyl propanol quickly into mix and then mix slowly to avoid further aeration.

Body Cream

Ingredient (INCI name)	Ingredient (trade name)	% w/w
Part 1		
Deionized water		81.47
Carbomer	Ashland 980	0.15
Glycerol		3.40
Part 2		
Polyglycerol-3 methyl glucose distearate	Tego* Care 450	1.30
Glyceryl Stearate	Tegin* M	0.80
Stearyl Alcohol	Tego* Alkanol 18	2.50
Butyrospermum Parkii Butter	Cetiol* SB45	0.50
Cetearyl Isononanoate	Cetiol* SN	2.00
Dicaprylyl Ether	Cetiol* OE	2.00
Octyl Dodecanol	Tegosoft* G20	1.50
Isopropyl Palmitate		4.50
Capric/Caprylic Triglyceride	Tegosoft* CT	1.50
Part 3		
DMDM Hydantoin, Iodopropyl Butylcarbamate	Glydant Plus*	0.30
Sodium Hydroxide (20% sol.)		0.18

Procedure

1. In the main vessel, disperse Ashland 980 carbomer into DI water with rapid agitation; then add glycerin, mix well and heat to 75°C.
2. In a separate vessel, add all ingredients of part 2 and melt to 75°C.
3. Add part 2 to part 1, while stirring and then homogenize.
4. Cool to 40°C; then add Glydant Plus*.
5. Neutralize with sodium hydroxide. Mix well and cool further down to room temperature.

Hand and Body Lotion

INCI name	Brand name	Use level%
Water		q.s 100.0
Glycerin	Glycerol	3.0
Carbomer	Ashland 981	0.5
Glyceryl stearate (and) PEG-100 stearate	Tegocare* 165	2.0
Cetearyl Alcohol	Tego* Alkanol 1618	1.0
Shea Butter	Cetiol *SB45	2.0
Mineral oil		5.0
Caprylic/capric triglyceride	Tegosoft* CT	5.0
Dimethicon/dimethiconol	DC 1503	1.0
Methylisothiazolinone (and) Phenethyl alcohol (and) PPG-2-Methyl Ether	Optiphen* MIT Plus	0.2
Fragrance		0.4
Sodium hydroxide solution (18%)		to pH 6 – 6.5

Method:

1. Add glycerin to water.
2. Add the Ashland 981 carbomer slowly while mixing.
3. Heat to 75 – 80°C
4. Add TegoCare* 165 while mixing
5. Add Cetiol SB45* while mixing
6. Add mineral oil while mixing
7. Add Tegosoft* CT while mixing
8. Add DC1503 while mixing
9. Homogenize for 5 minutes at 4000 rpm
10. Cool to 40°C
11. Add preservative and fragrance
12. Homogenize for 5 minutes at 4000 rpm
13. Add NaOH solution till pH is 6.0 - 6.5.

Regulatory and Safety Information

The safety of carbomers has been assessed by the Cosmetic Ingredient Review (CIR) Expert Panel. The CIR Expert Panel evaluated the scientific data and concluded that carbomer polymers were safe as ingredients in cosmetics and personal care products. In 2001, as part of the scheduled re-evaluation of ingredients, the CIR Expert Panel considered available new data on carbomer polymers and reaffirmed the above conclusion. Ashland carbomers are produced in China for Ashland, doing business as Ashland Specialty Ingredients, and manufactured to comply with GMPs for cosmetic ingredients.

Andrea Gallo di Luigi S.r.l.
Via Erzelli, 9
16152 Genova
info@andreagallo.it
www.andreagallo.it