

AQUEOUS ELASTOMERIC IMPRESSION MATERIALS

The aqueous elastomeric impression materials are one of two classes of elastomeric impression materials, the other being the non-aqueous materials which include the condensation and addition polymerizing silicones, the polysulfides, and the polyethers. The aqueous elastomeric impression materials are of two types: the reversible and irreversible hydrocolloids. The hydrocolloids are based upon colloidal suspensions of polysaccharides in water. They exist in a form that is between that of a solution (individual atoms or molecules dispersed in a medium) and a suspension (aggregations of atoms or molecules dispersed in a medium). They may also be thought of as consisting of a dispersed particle phase (agar) and dispersion medium phase (water). Dental hydrocolloids exist in two forms: a sol (a more or less viscous liquid) and a gel (an elastic solid). The impression material is introduced into the mouth as a sol and converts into a gel through either a chemical or a thermal process.

Reversible Hydrocolloids

Composition

Component	Percentage
water	85
agar (a complex polysaccharide of alginic origin)	8-15
potassium sulfate (K_2SO_4) [to offset the retarding effect of the agar and borax on the gypsum]	1-2
borax (to strengthen the fibrils)	0.2-0.5

Commercial Examples

Acculoid Lavender (Van R)
Slate Hydrocolloid (Van R)
Super body 500 (Gingi-Pak Pharmaceutical)

These materials convert from a sol to a gel through a reduction in temperature and a change in the physical state. This is a reversible process. The conversion from gel to sol occurs at 100 degrees C (212 degrees F) and the change from sol to gel take place at approximately 43 degrees C (109 degrees F).¹ When this is done in a clinical situation, the tubes containing the tray material and tubes containing the syringe material are placed in the first compartment of a three-compartment unit. The first compartment is used to boil the tubes in water at 212 degrees F for 8 to 12 minutes. This

effectively converts them from gel to sol. Longer periods of boiling will not harm the gel. They are then stored in the middle compartment at 151 degrees F for a minimum of 10 minutes (they can be stored for up to 8 hours). Then, just before use, the tray material is expressed into the tray and is stored for 10 minutes in the third bath at 115 degrees F to lower its temperature and prevent the patient from being burned. This tempering also increases the material's viscosity so it will remain in the tray during manipulation. The tube of syringe material is not tempered prior to use because when it is ejected from the tip of the syringe, it is much cooler than the material remaining in the tube. This difference in temperature eliminates the possibility that the material will burn the patient. Another reason for not tempering the syringe material relates to its viscosity. It is less viscous than the tray material because it is only 6 to 8% agar (the difference being water). This allows it to flow better when syringed around the preparations. If the material were to be tempered, its viscosity would increase and its effectiveness as a syringe consistency material would be reduced.

Setting Reaction

When the reversible hydrocolloids convert from sol to gel, they do so because the agar chains align to form fibrils which trap water in their interstices. This produces the characteristic hydrocolloid.

Syneresis, Imbibition, Hysteresis

Because these materials are essentially three-dimensional semi-permeable membranes when set, they exhibit syneresis and imbibition. Syneresis refers to the fact that the material contracts with time and exudes water. This occurs because the forces which caused the fibrils to form in the first place continue to exert their effects which bring them closer together. This has the result of causing shrinkage of the impression. On the other hand, these materials are also prone to water absorption when exposed to water or high humidity. As a consequence of taking in water, the material swells. Both syneresis and imbibition have the potential for causing dimensional changes and account for the poor dimensional stability of the hydrocolloids. Hysteresis refers to the fact that the material's sol temperature is higher than its gel temperature. This is extremely important because without the difference, it could not function effectively as a dental impression material.

Clinical Use

Some aspects of preparation of the material have already been mentioned with regard to its conversion from gel to sol, storage, and tempering. When inserted into the mouth during

impression making, a rim lock, water-cooled tray is used. Cool water is coursed through the tray for 3 to 5 minutes to hasten the agar's conversion from sol to gel. The water used should be no cooler than 60 to 70 degrees F, however, because since the material gels from the tray outwards, too rapid a gelation may distort the gel and produce an inaccurate impression. After gelation, which takes a minimum of 5 minutes, the impression should be removed quickly with a snap. An attempt should also be made to remove the tray parallel to the long axes of the teeth. These techniques maximize tear strength and minimize permanent deformation. The impression should be poured immediately to prevent changes in its dimensions due to syneresis or imbibition. Before newer formulations came on the market, the reversible hydrocolloids were known to adversely affect the surface of Type IV stones by making them chalky and soft. As a means of preventing this, impressions were often soaked in a potassium sulfate solution prior to pour-up.

Advantages

Low cost of the impression material, high degree of wettability, nontoxic, nonstaining, require no mixing

Disadvantages

Difficult to disinfect, high cost of equipment, low tear strength, poor dimensional stability, must be poured immediately

Irreversible Hydrocolloids

Composition

Component	Percentage
diatomaceous earth	60
calcium sulfate dihydrate	16
potassium agitate	15
zinc oxide	4
potassium titanium fluoride	3
trisodium phosphate	2

Fluoride is frequently also present (often as Na_2SiF_6) in concentrations ranging from 0.3 to 4% to improve the quality of the stone poured against the set agitate.²

Commercial Examples

Jeltrate (Dentsply/Caulk)
 Integra (SDS/Kerr)

Coe Alginate (GC America)
Identic (Cadco)
Supergel (HJ Bosworth)

Setting Reaction

When mixed with water, the calcium sulfate dihydrate and trisodium phosphate retarder react to form calcium phosphate. When the trisodium phosphate is completely used up, the calcium sulfate dihydrate is free to react with potassium alginate to produce calcium alginate and potassium sulfate. Gelation of the impression material occurs as the calcium ions crosslink the alginate chains. Because the trisodium phosphate prevents the second, more desirable reaction from occurring, it functions as a retarder and provides the clinician with greater working time.

Setting Time

Water/powder ratio should not be altered as a means of manipulating setting time with these material because this will reduce gel strength and change dimensional accuracy. Rather, it is better to change the temperature of the mixing water. By reducing the temperature 1 degree C, the setting time for some brands of alginate will be lengthened by up to 20 seconds.

Clinical Use

Immediately prior to inserting the alginate impression, the surface should be smoothed with a wet finger. This has been shown to reduce the entrapment of air against the teeth and tissues.³ The impression should be removed from the mouth 2 to 3 minutes following gelation and should be removed quickly, with a snap. This maximizes tear strength and minimizes permanent deformation because these materials are viscoelastic. If they are loaded slowly, they undergo a great deal of deformation but if loaded rapidly, they undergo little deformation. The impression should be poured immediately to prevent dimensional changes. The cast should not be separated from the impression until 45 to 60 minutes have passed. Prolonged contact between the alginate and gypsum should be avoided because a soft, chalky cast surface may be produced. Certain Type IV stones also exhibit a chalky, soft surface when poured against alginate because a layer of unreacted calcium sulfate hemihydrate as thick as 80 microns often forms.⁴ Because of this problem, its inability to reproduce fine detail, and its poor tear strength, alginate is not used for making final impressions for fixed prosthodontics.

Advantages

Low cost, high degree of wettability, pleasant taste

Disadvantages

Poor dimensional stability, inability to reproduce fine detail, incompatibility with some gypsum materials, difficulty in disinfecting, poor tear strength, must be poured immediately

Several disinfectant-containing alginates are on the market:

Coe Hydrophilic Gel (GC America) is a dustless alginate that contains 1.0% chlorhexidine diacetate as an antimicrobial agent.

Jeltrate Plus Antimicrobial Alginate (Dentsply/Caulk) contains 1.7% didecyl-dimethyl ammonium chloride and has exhibited an ability to markedly reduce the number of bacteria present.⁵

Identic Dust Free (Cadco) contains a proprietary antimicrobial agent. Little research information is available on this product.

Blueprint Asept (de Trey) is available in Europe and is similar to Caulk's Jeltrate Plus. It contains didecyl-dimethyl ammonium chloride and has been found to be effective in reducing bacterial counts.⁶

General Information

It has been suggested that airborne particles from alginate impression powders have the potential for causing respiratory problems. One study found that from 10 to 15% of these particles are siliceous fibers in the 3 to 20 micron size range; these dimensions are similar to those of asbestos and glass particles which are known carcinogens. In an attempt to reduce this hazard, dustless alginates have been developed by coating the particles with a glycol.⁷

The most accurate way of dispensing alginate is by weighing it; volumetric dispensing can differ from the recommended weight by from 10 to 20%.⁸

References

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