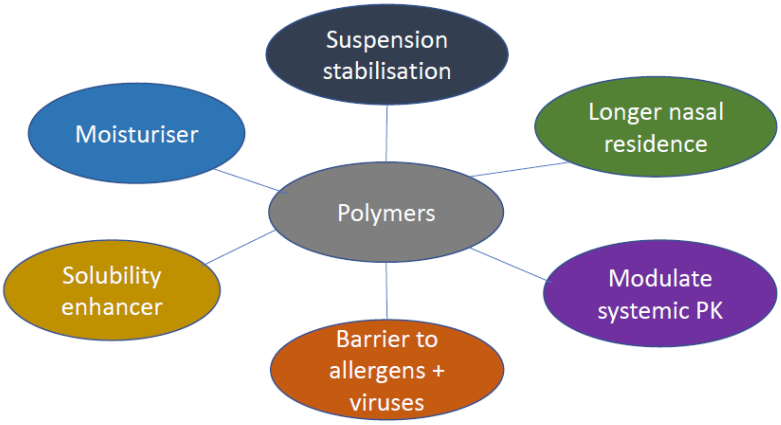
Polymers in Nasal Products

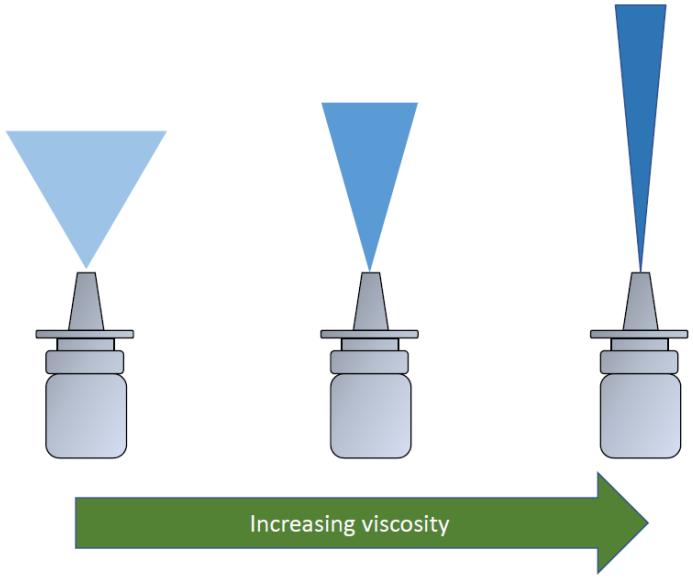
Background

This paper provides a concise overview of key polymers used in marketed nasal products. The functions served by the polymers described broadly fit into one or more of the categories illustrated below:



Product Development Considerations

From a formulation and device development perspective, solutions containing polymers will be more viscous; this will increase droplet size and reduce plume angle, which in turn will affect the deposition pattern.



The worst-case scenario is the product will be emitted from the device as a liquid jet and not a spray plume, which will limit coverage within the nasal cavity and may also cause discomfort. Nasal device modifications may be able to mitigate to some extent the effects of viscosity on spray properties. There are some polymer systems which have a relatively low viscosity,

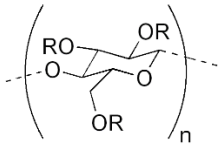
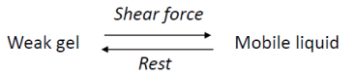
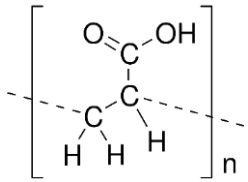
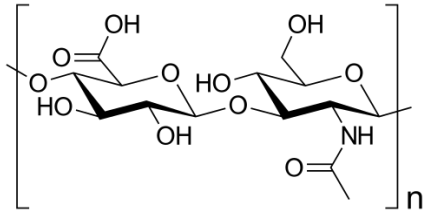
enabling effective atomisation and good deposition properties, but undergo a phase change only when deposited in the nasal cavity.

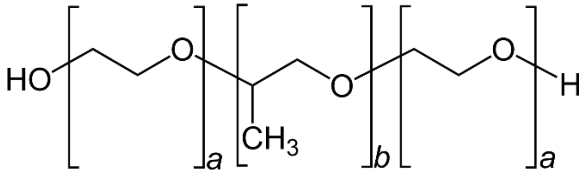
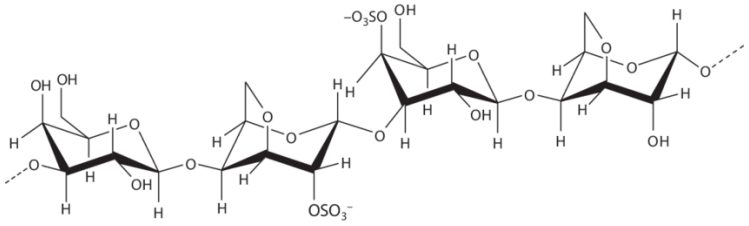
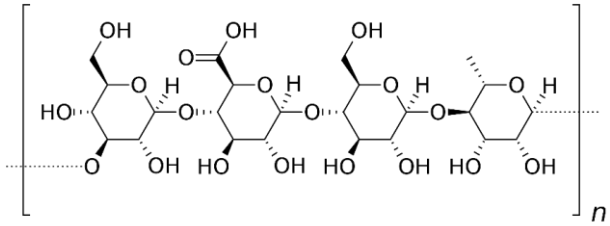
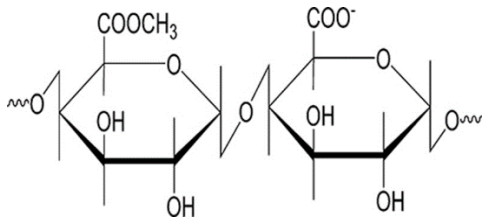
Regulatory

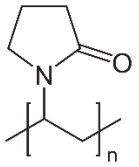
Any product containing a drug and/or claiming a clinical benefit will need to be licenced as a medicine.

In recent years, several “barrier” products have entered the market. They contain polymers designed to form a barrier on the nasal mucosal surface to entrap allergens or viruses; interest in the latter has notably increased because of the COVID pandemic. These products have predominantly been licensed as medical devices. Antiviral data are primarily from in vitro or animal studies, although clinical data are being generated for some products.

Polymers and Example Products

Polymer	Function	Product Examples [D = medical device]
Hypromellose  R = H or CH_3 or $CH_2CH(OH)CH_3$	Viscosity enhancer • Increased nasal residence • Barrier formation	Solutions • Vicks First Defence – barrier [D] • Rhinolast® (azelastine) – antiallergy • Otrivine® nasal drops (xylometazoline) – decongestant Powders • Nasaleze® - barrier [D] • Taffix™ - barrier [D]
Co-processed microcrystalline cellulose and carboxymethylcellulose sodium e.g. Avicel® RC; Vivapur® MCG	Forms a thixotropic aqueous dispersion. Acts as suspending agent for API particles. Good spray atomisation, will thicken in nasal cavity to reduce drip / extend residence  	Used in multiple nasal corticosteroid aqueous suspension sprays e.g. budesonide, fluticasone, beclomethasone, mometasone, triamcinolone
Carbomers (polyacrylic acid)  	Viscosity enhancer	Viraleze® – barrier product which also contains astodrimer sodium, a dendrimer reported to bind and inactivate viruses [D]
Hyaluronic acid  	Moisturiser and viscosity enhancer	• Hysan® nasal spray [D] • Oraldent Cold & Flu Guard™ [D] • Sudafed® Congestion Relief nasal spray (xylometazoline)

Polymer	Function	Product Examples [D = medical device]
Poloxamer 	Present in oxymetazoline nasal spray – most likely as a surfactant / solubilising agent, since the product contains poorly soluble ingredients such as camphor and eucalyptol	Oxymetazoline hydrochloride 0.05% w/v nasal spray (Galpharm) – contains poloxamer 188
Carrageenan 	Contains anionic (sulfate) groups in aqueous solution which can interact with calcium ions found in nasal secretions to form gels; this is achieved by crosslinking adjacent polymer chains to form a 3D network. It is reported that carrageenan may also be able to bind and inactivate viruses	• Norizite™ nasal spray - carrageenan / gellan blend [D] • Boots Dual Defence - Carragelose® (iota-carrageenan) and kappa-carrageenan [D] • Lemsip First Action™ - Carragelose® (iota-carrageenan) and kappa-carrageenan [D]
Gellan gum 	Contains anionic (carboxylate) groups in aqueous solution which can interact with calcium ions found in nasal secretions to form gels	Norizite™ nasal spray - Carrageenan / gellan blend [D]
Low methoxy (LM) pectin 	Contains anionic (carboxylate) groups in aqueous solution which can interact with calcium ions found in nasal secretions to form gels	PecFent® (fentanyl) – pectin gel formation in nasal cavity modulates fentanyl pharmacokinetic profile (attenuated C_{max}) vs. simple solution

Polymer	Function	Product Examples [D = medical device]
Povidone 	Povidone is described as a "mucoadhesive" in Ventizolve® spray (naloxone)[1], although this is not a widely recognised property of the material	Ventizolve® (naloxone) – emergency treatment of opioid overdose

[1] https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/2650948/add.14552.pdf?sequence=2

For more information, please contact peter@phormulate.com