

## Carbomer 941로 사용한 안정된 O/W 형 에멀전에서 첨가제에 의한 점도변화

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## Viscosity variation with additives on Oil-in-Water emulsion stabilized with Carbomer 941

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### Introduction

In recent years the cosmetic industry has acknowledged the importance of rheological properties of emulsion as well as finished products.

Product rheology plays a significant role in defining and controlling these attributes.

Rheology, or flow behavior, may be modified to produce pseudoplasticity, thixotropy, gel structure, or short or stringy pituitous flow(1). The ability of thickener to modify finished product's rheology has direct impact on shelf stability, whether it is due to viscosity control, emulsion stability, suspension of actives, or prevention of syneresis(2). The emulsions are complex because the drops can deform and the surfaces are fluid(3).

The formation of emulsion is a dynamic, yet thermodynamically unfavorable, process due to the increase in interfacial area following emulsification.

Macroemulsions composed of drops in the micron-size range are not thermodynamically stable and there are various sources of instability leading to phase separation.

The rheological behavior of carbomer941-thickened oil-in-water emulsions is studied with a cone-and-plate system using a constant-stress rheometer. Carbomer941 polymer solutions and carbomer941-thickened oil-in-water emulsions are strongly shear-thinning and viscoelastic in nature. The effects of polymer and oil concentrations on the rheological behavior of emulsions are investigated. The relative

viscosity for the thickened emulsions, at any given oil concentration, increases with an increase in the shear rate, whereas the unthickened emulsions show the opposite trend. The theoretical models give reasonable predictions for the relative viscosity, storage modulus, and loss modulus of carbomer941-thickened emulsions. The ratio of storage to loss moduli increases considerably with the increase in additives. The creep/recovery experiments confirm that the carbomer941-thickened emulsions are highly viscoelastic in nature and that the degree of elasticity increases with the increase in the amount of additives added.

In order to investigate systematically the steady shear flow properties of aqueous (carboxyl polymer) solution having various molecular weights and concentrations, the steady flow viscosity has been measured with a Rheometrics(HAAKE).

There are five main mechanisms that can contribute to emulsion instability; ① creaming, ② flocculation, ③ ostwald ripening, ④ partial coalescence, and ⑤ phase inversion (walstra)(5).

Creaming is due to differences in density between the two phases under the influence of gravity which leads to phase separation.

The objectives of this study are to investigate how the used components, the addition ratios of the additives, and the types of the oil-in-water emulsions will affect the stucture and rheological properties of oil-in-water emulsions stabilized with carbomer941.

## **Materials and methods**

**Materials** : The carboxyl polymer increasing emulsification was Cabomer 941. The surfactant was non-ionic P.O.E(20)Sorbitan monostearate(Tween60). The oils were olive oil and liquid paraffin. The emulsifiers were stearic acid, cethyl alcohol, glycerin monostearate, glycerin stearate, and PEG100stearate. The preservations were methyl parahydroxybenzonate, buthyl parahydroxybenzonate, and buthyl hydroxyl toluene. The neutuilized material was triethanolamine. The addictives of alkali were sodium hydroxide and calcium hydroxide. The addictives of acid were hydrochloric acid and sulfuric acid. The addictives of salt were sodium chlroride and magnecium chlroride.

**Methods** : Emulsions were prepared in laboratory scale(batch size 100g). Distilled water was added to the mixture of surfactant and oil at the temperature of 75~80°C within 3min, and mixed at a speed of 2000rpm with blender (T.K.ROBO MICS, Tokushu kika kogyo CO.,Ltd, Japan). During the cooling phase the emulsion was continuously mixed. The mixture was introduced into additives solution, previously brought to agitated with direct driven stirrer.

**Rheology** : A rheometer (HAAKE RT-20, Germany) was used to determine viscosity. A cone plate geometry was employed for high accuracy and sensitivity. The temperature is measurement 25°C. The distance between the shearing surfaces was 1.055mm.

**pH meter** : The emulsions pH were mearsured with pH meter. The error range of pH controlled was  $\pm 0.1$ .

**Motor centrifuge** : The stabilized emulsions were confirmed by motor centrifuge. Centrifugation experiments were performed with a Brushless D.C Motor VS-15CF, Korea apparatus at 3000rpm for 10min. The physical stability of emulsion was described with the separation of the oil phase and with the volume of the separation water.

**Zeta-potential analyzer** : Measurement was made with a Malvern, Zetasizer 3000HS in which microelectrophoresis was coupled with a photocorrelation spectroscopy, based on helium/neon laser. The evaluation was carried out by an on-line computer. The buffering solution KCl 0.020 m(20mM) electrolyte at pH 7. The injection was made at 25°C with an applied electronic field from -150 to +150 mV.

### Results and discussion

Cosmetic oil-in-water emulsions are stabilized by cross linked carbomer941 that effectiveness can be further improved with the introduction of hydrophobic side-chain(4).

In order to investigate how partial coalescence affected the emulsion used centrifuge was used

In this experiment emulsions, skin brings up for discussion pH similar condition 5. 5~6.5 and it fixes in the pH which is emulsion prescription.

The additives of stabilized emulsions having different concentrations were determined by use of pH meter.

Fig.1, in case of  $r=50$ , additives shows the tendency that the viscosity in the additive will decrease. The force increases effect of viscosity compared to diminish it.

Fig.2, in case of  $r=50$ , the additive will increase 24pa that it shows that the viscosity decreases and the additive increases, it is shown a similar viscosity aspect.

Fig.3, in case of  $r=50$ , the additives of  $H_2SO_4$  increases with viscosity increase. The viscosity increasing showed that the inside structure does to compare with each other and additive 2.5(w/w)%.

Fig.4, in case of  $r=50$ , the additives of HCl additive increases, it shows a similar aspect and 2.5(w/w)% after it is sudden that it diminishes and the structure is destroyed a possibility of knowing.

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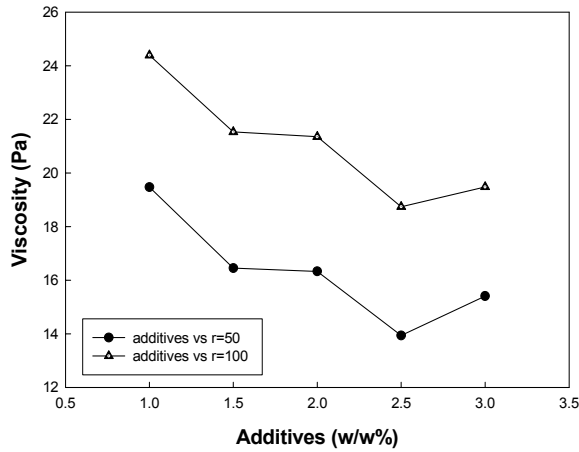


Fig.1 The additive (NaOH) course of viscosity in shear rate (Left)

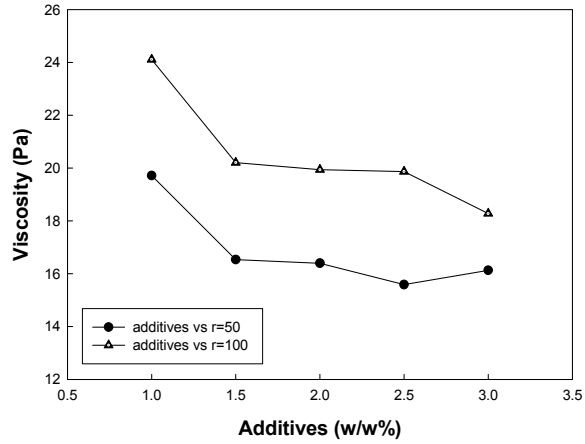


Fig.2 The additive (MgCl<sub>2</sub>) course of viscosity in shear rate (Right)

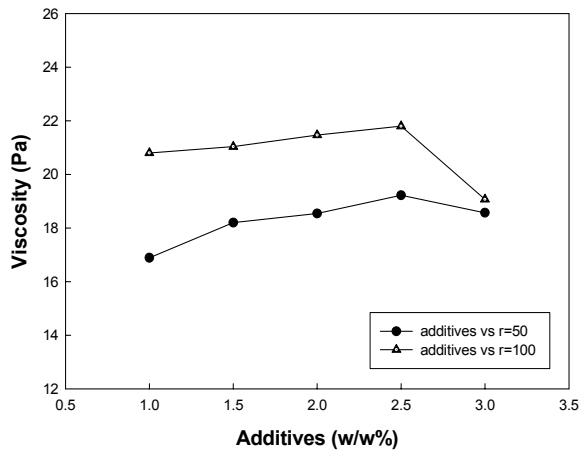


Fig.3 The additive (H<sub>2</sub>SO<sub>4</sub>) course of viscosity in shear rate (Left)

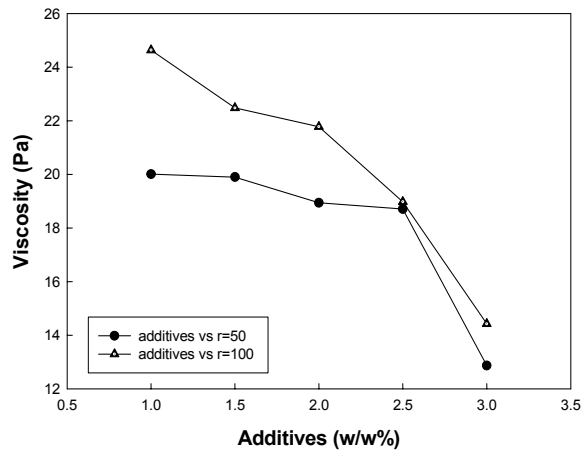


Fig.4 The additive (HCl) course of viscosity in shear rate (Right)