

# Effect of Salts on the Clouding and Micellization Behavior of Pluronic F127® Solutions

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## OBJECTIVES

We have investigated the effect of NaCl, Na<sub>2</sub>SO<sub>4</sub>, Na<sub>3</sub>PO<sub>4</sub> and NaSCN on the cloud point (CP), and critical micellization temperature (cmt) of F127 solutions. Salts have been shown to alter micellization of other non-ionic surfactants, and the gel transition temperatures of F127. Such changes are important to consider in formulation systems with F127.

## BACKGROUND

### Pluronic F127

PEO-PPO-PEO triblock copolymer  
(EO)<sub>99</sub>-(PO)<sub>65</sub>-(EO)<sub>99</sub>  
MW=12,500  
approx.. 70% PEO, 30% PPO  
also called poloxamer 407

Pluronic F127® is used in formulations as a solubilizer, surfactant and gel forming agent. Many of these formulations contain salts as buffers or ionic strength adjusters. These salts can have a significant influence on the properties of non-ionic surfactants such as F127.

**Cloud Point:** Aqueous solutions of PEO and PEO-containing surfactants phase separate on heating at a critical temperature called the cloud point (CP).

**Cmt:** F127 micellization is strongly dependent on temperature; as T increases, the cmc decreases. The temperature at which any particular F127 solution will form micelles is called the critical micellization temperature, cmt.

## METHODS

### Cloud Point:

CP was measured by gradually heating (2-3°C/min) stirred solutions of F127 until they turned cloudy. Each CP was determined in triplicate.

### Cmt:

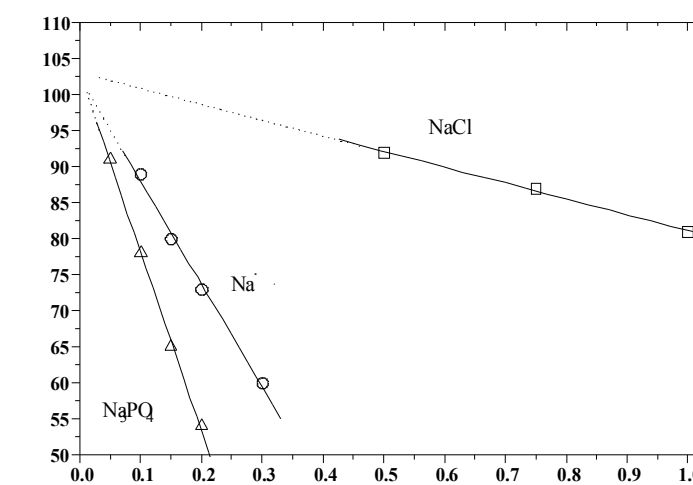
Cmt was determined by static light scattering using a fluorimeter. The solutions were exposed to a wavelength of 336 nm and the intensity of the Rayleigh scattering peak at 336 nm was monitored. The solution was then heated gradually and the temperature and scattering intensity were continuously measured. The temperature at which light scattering increased dramatically was designated as the cmt.

### Micelle Polarity:

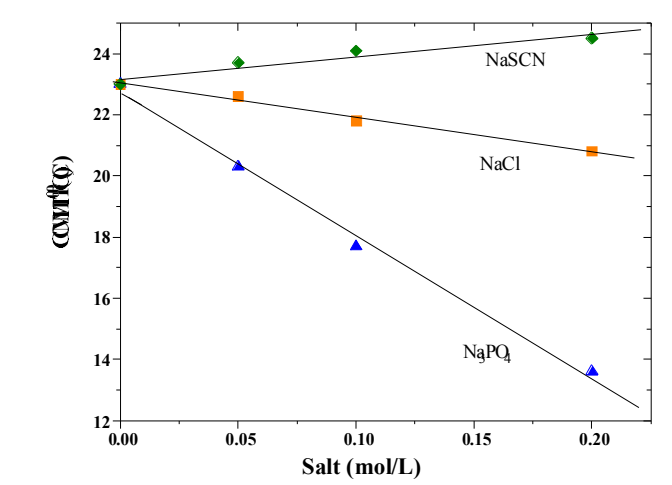
Pyrene (~ 10<sup>-4</sup>-10<sup>-5</sup> M) was used as a fluorescence probe. Solutions of F127 and salts containing pyrene were excited at 336 nm, and emission spectra were monitored as a function of temperature. The ratio of the 374 nm band to the 385 nm band (the I<sub>1</sub>/I<sub>3</sub> ratio) is a measure of the polarity of the micelle interior, where the pyrene resides. Excimer formation (460 nm) was also monitored, and this gives a measure of the distribution of pyrene in the micelles.

## RESULTS

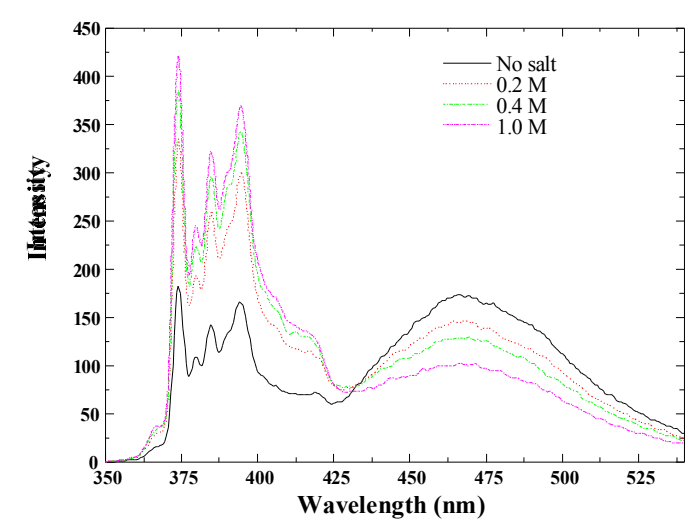
Effect of salts on the cloud point (CP)



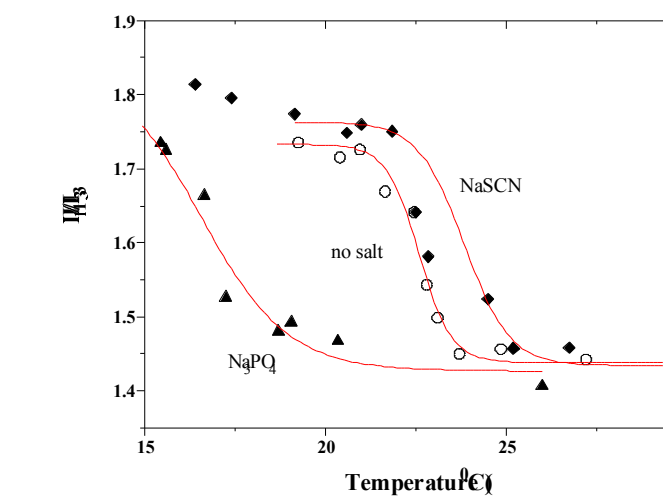
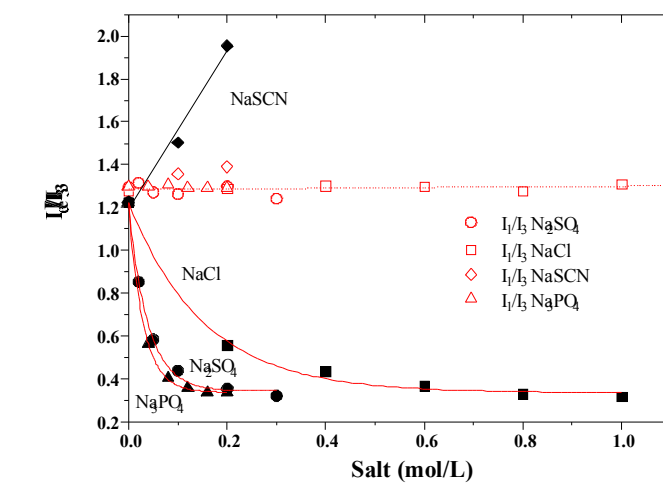
Effect of Salts on the Critical Micellization Temperature (cmt)



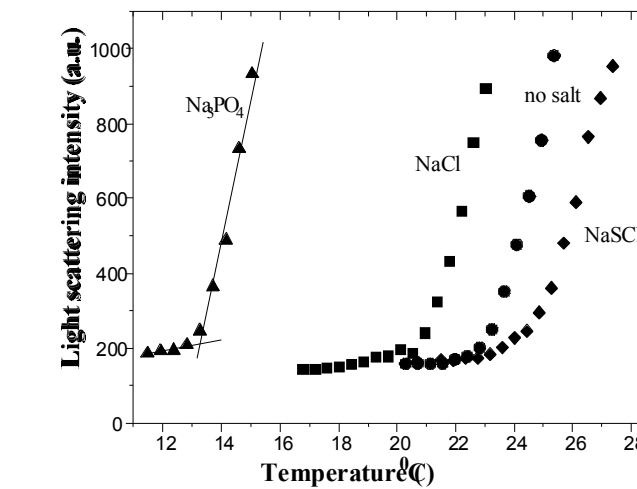
Pyrene spectra in F127/NaCl solutions



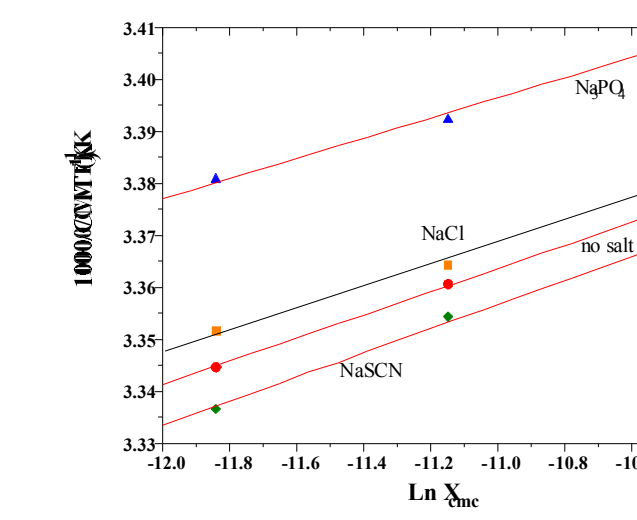
Effect of salts on I<sub>1</sub>/I<sub>3</sub> and I<sub>e</sub>/I<sub>3</sub>



Effect of salts on cmt by static light scattering

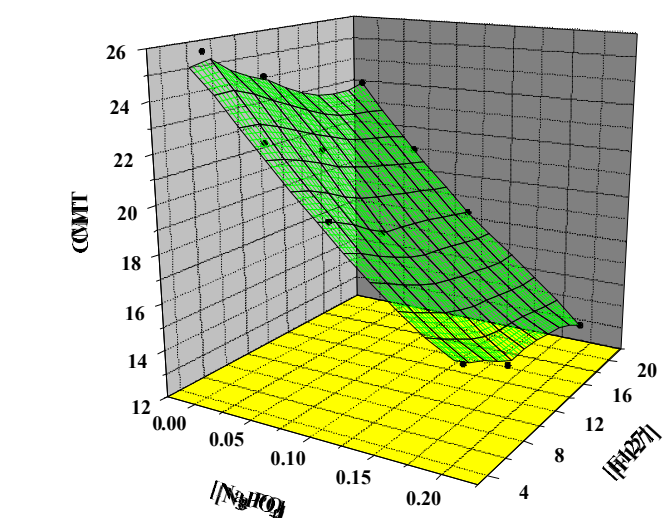


Thermodynamics of F127 micellization



$$1/T = (R/\Delta H) \ln X_{cmc} + \Delta S/\Delta H$$

3-D view of F127 and salt conc. on cmt



## CONCLUSIONS

1. The cmt of F127 is lowered by NaCl, Na<sub>2</sub>SO<sub>4</sub> and Na<sub>3</sub>PO<sub>4</sub>; and raised by NaSCN.
2. The constant I<sub>1</sub>/I<sub>3</sub> ratio shows that salts do not significantly alter the micropolarity of the micelle interior.
3. The change in the I<sub>1</sub>/I<sub>3</sub> ratio with salt concentration shows that salts alter the aggregation number, micellar volume or the microviscosity of the micelles.