CHARACTERISTICS OF CEMENT SUPERPLASTICIZER BASED ON POLYMELAMINE SULPHONATE

Agnė Zdaniauskienė*, Asta Judžentienė

Organic Chemistry Department, Center for Physical Sciences and Technology, Vilnius, Lithuania

**E-mail: agne.zdaniauskiene@ftmc.lt*

INTRODUCTION

Superplasticizers (SPs) are effective organic additives for reducing water content, giving homogeneity and non-segregation, lowering porosity, increasing mechanical strength and workability, and achieving sufficient fluidity and good plasticity of cement. SPs possibly decompose into relatively small molecular weight polymers over the long term, and these organic substances may be leached into groundwater from cementitious materials.

According to the market analysts, the sulfonated melamine formaldehyde condensates segment held a 30.9% share of the overall market, which is highest among other types of concrete superplasticizers. The segment is forecast to generate revenue of $1411.25m by 2023, growing at an estimated CAGR of 9.54% during the forecast period 2018–2023.

EXPERIMENTAL

Peramin ® SMF10 based on polymelamine sulphonate (PMS)

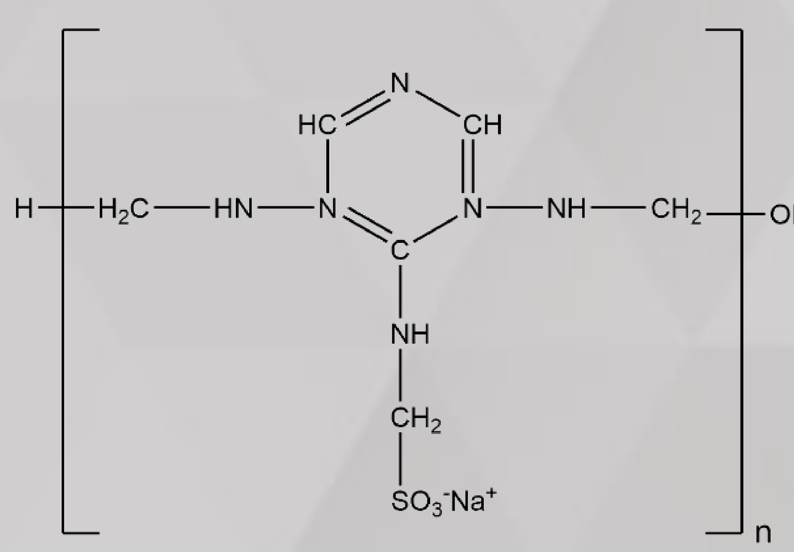

Figure 1. Chemical structure of polymelamine sulphonate (PMS)

Visual aspect: off-white powder or dust
Density: 450 – 650 kg/m^3
Dosage: 0.2 – 2.0 % by weight
pH (aqueous solution): 8.8 (5%)
Main functions: to give homogeneity, to lower porosity and non-segregation of mortar and grout; to reduse water content, thus increasing mechanical strength, fluidity and workability, improving resistance to aggressive environments. Without the superplasticizersthe concrete would contain ~9 – 11% of water, compared to 7 – 9% with superplasticizers.

Wavelength dispersive X-Ray Fluorescence

Detailed chemical analysis of Peramin ® SMF10 was performed by Wavelength Dispersive X-Ray Fluorescence (WD-XRF) spectroscopic method using AxiosmAX (Malvern PANalytical) spectrometer equipped with SST-mAX X-ray tube (Rh anode, 4 kW); and results of quantitative analysis were obtained using sofware Omnian (PANalytical).

Thermo-gravimetric analysis

Physicochemical properties of the superplasticizer were evaluated by thermo-gravimetric analysis at a range of 30 – 800 °C. Atmosphere - air. Three mass losses was observed.

Raman measurements

In order to investigate the rate of alkaline degradation of the SP in different aqueous solutions Raman spectroscopy has been applied. Raman spectra were recorded using Echelle type spectrometer RamanFlex 400 (PerkinElmer, Inc.) equipped with thermoelectrically cooled (-50 ^{o}C) CCD camera and fiber-optic cable for excitation and collection of the Raman spectra. The 785 nm beam of the diode laser was used as the excitation source. The laser power at the sample was restricted to 100 mW. The integration time was 300 s.

RESULTS

Table 1. Detailed chemical composition of product **Peramin ® SMF10**

No.	Compound	Percentage
1.	**PMS**	**99.824**
2.	Na_2O	0.021
3.	Al_2O_3	0.017
4.	SiO_2	0.021
5.	P_2O_5	0.054
6.	K_2O	0.006
7.	CaO	0.017
8.	Fe_2O_3	0.005
9.	ZnO	0.033
10.	*Cl^-	0.004

Chemical composition (%) of product Peramin ® SMF10 according to the Product Data Sheet: dry content 93.2 % (93.5± 2), Na_2O+0.658 K_2O 12.0 (< 13), *Cl^- (as ions) 0.004 (<0.05).

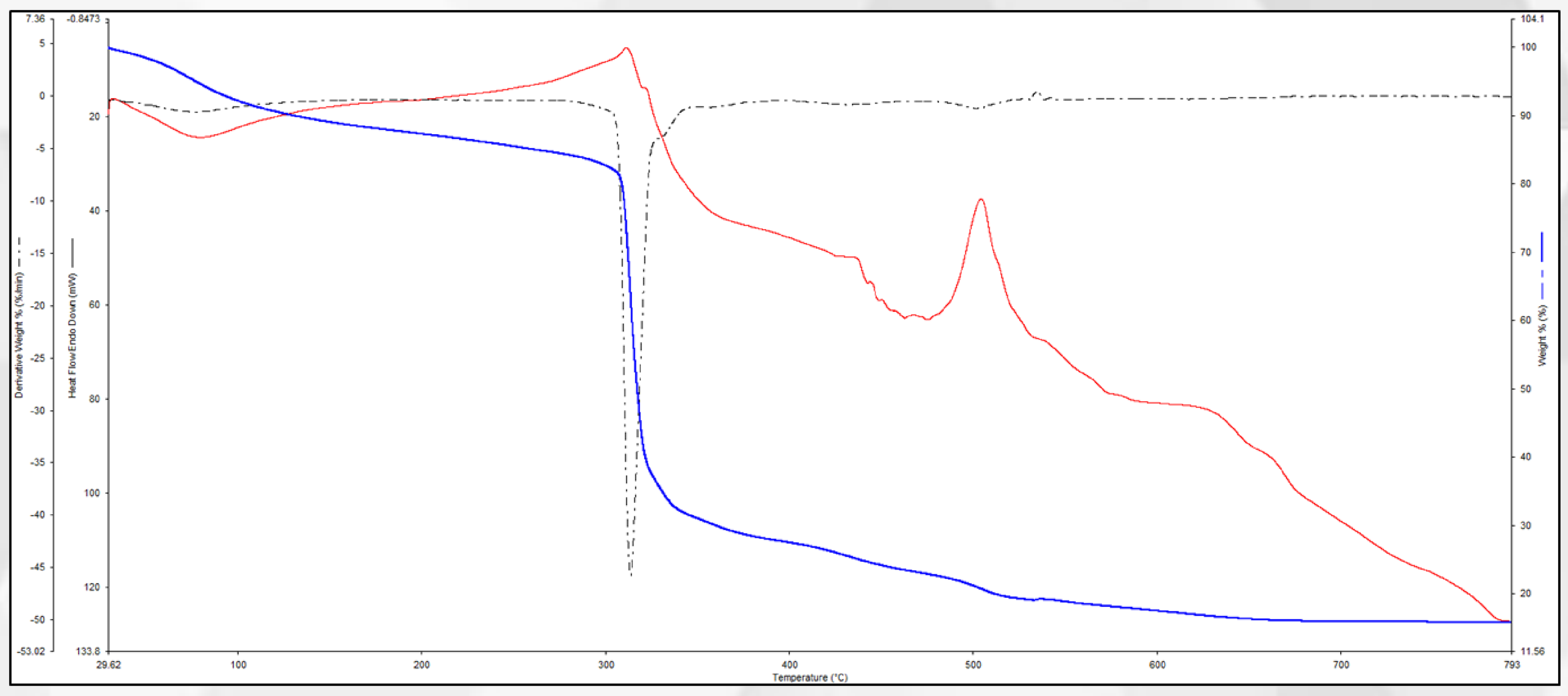

Figure 2. Thermo-gravimetric analysis of Peramin ® SMF10. Curves: blue (TG) – percentage weight loss (TG); black – derivative weight loss (DTG) (% / min); red – differential scanning calorimetry (DSC) (heat flow (mW)).

Thermal processes (red curve - heat flow):
1) 36 – 136 °C endothermic evaporation of adsorbed H_2O (approx. 7% mass loss).
2) 284 – 349 °C exothermic decomposition of polymer / polymer matrix, possibly with formation of monomers and further oxidation of monomers (48% mass loss).
3) 473 – 546 °C exothermic complete oxidation of de-polymerization products (final mass 15% of initial sample).
Thermal stability of the sample – the polymer is stable up to 270 °C. The residual ash of the sample may consist of finely divided SiO_2 or metal carbonates / oxides (according to composition table from elemental analysis).

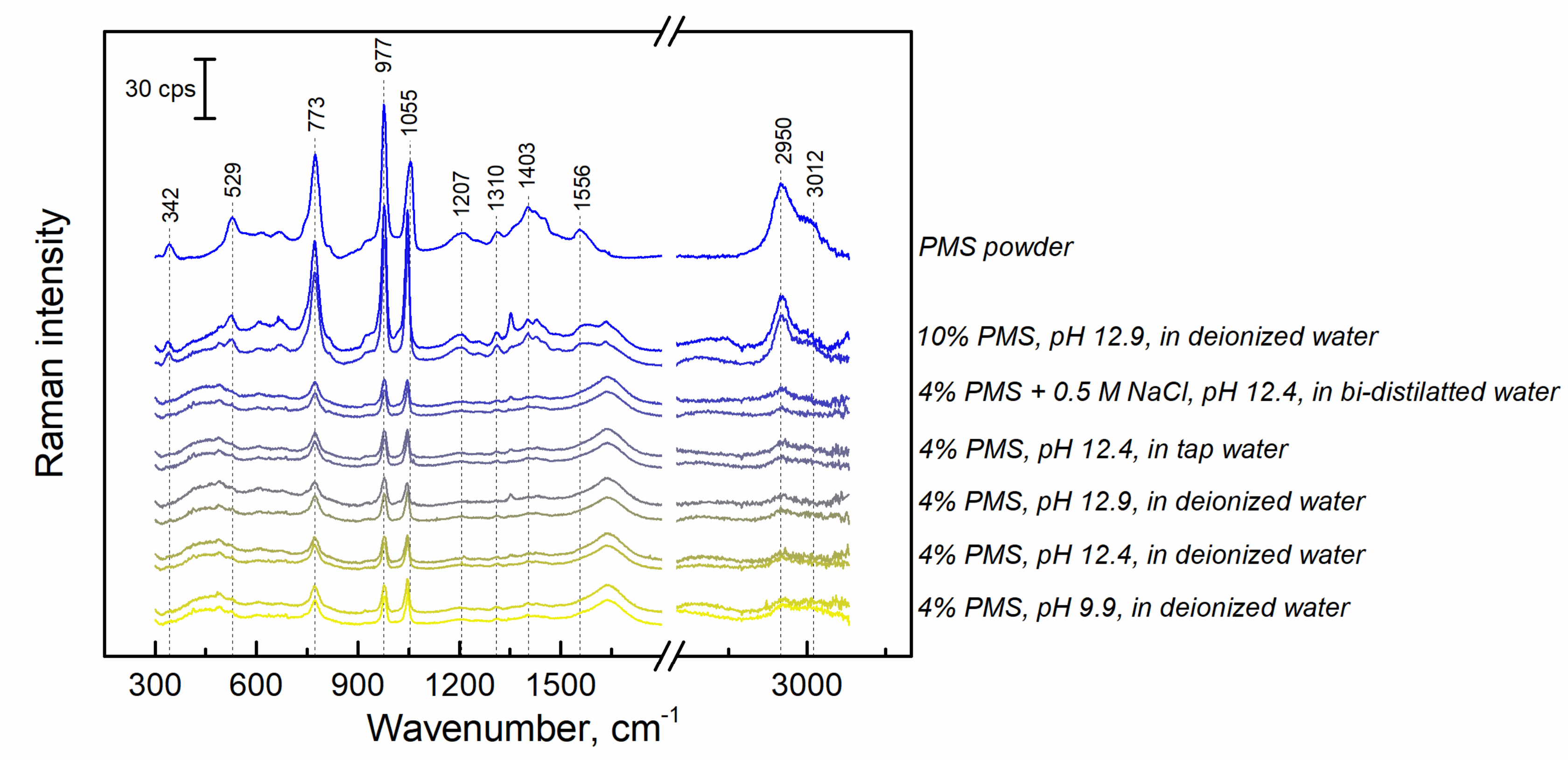

Figure 3. Raman spectra of different PMS hydrolytic solutions during the time. The upper curves indicate solutions after 3 months, the lower ones – just made samples.

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