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USE THERMAL ANALYSIS (TG/DTG/DSC) IN THE STUDY OF STABILITY  
(BIO)POLYMER BINDER

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**Keywords:** polymer binders, foundry sands, thermal analysis, TG/DTG/DSC, thermal degradation

## 1. Introduction

This publication presents the results of thermal examinations conducted to determine the course of the thermal degradation of a water-based (bio)polymer composition of synthetic polymer/ modified biopolymer with a view to its use as a foundry binder for moulding and core sands (BioCo1). Thermal decomposition of the BioCo1 binder is of essential meaning in relation to this binder behaviour at increased temperatures during the mould pouring with liquid metal as well as in relation to this used sand reclaimability. From the environmental point of view and work conditions, information concerning gaseous products of polymer decomposition, which can evolve into the atmosphere during the technological process, seems also important [1,2].

## 2. Experimental

### 2.1. Materials

New polymer binding agent BioCo1 in a form of two-component polymer composition formed by mixing in water a synthetic polymer (poly(acrylic acid) of the BASF Company) and a modified biopolymer (modified starch of the Xenon Company) in the weight ratio 1:1 was used in the performed investigations. Cross-linking of sample of the prepared composition was performed by means of  $\text{Ca}(\text{OH})_2$  and  $\text{CO}_2$ .

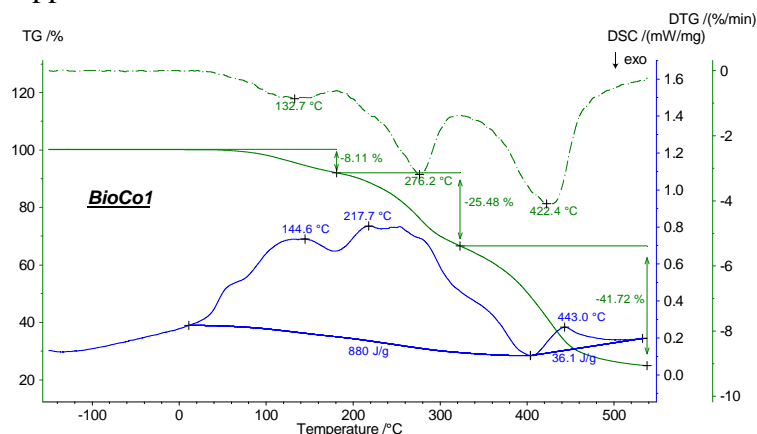
### 2.2. Thermal analysis methods

The thermal examinations were carried out by using a NETZSCH STA 449 F3 Jupiter® thermal analyser, which supports simultaneous TG and DSC measurements, thus providing two independent signals recorded in the same measurement conditions, namely at the same rate of temperature increase (10K/min), atmosphere and gas flow rate (40 ml/min). The measurements for the sample were taken in an anaerobic atmosphere.

## 3. Results and discussion

Figure 1 depicts the TG-DSC results for the sample BioCo1 (after cross-linking). At sub-ambient temperatures, no effects were observed. Three mass loss steps 8.1%, 25.5% and 41.7% were noticed, which were accompanied by endothermic effects visible in the DSC sig-

nal. Maxima in the rate of mass change occurred at 133°C, 276°C and 422°C. In the temperature range -100-0 °C the polymorphous transformations were not found. The pathway of thermal curves is complex since the degradation process occurs by stages, which results from the structure and physical and chemical properties of the two-component bio-polymer composition. On the grounds of the thermal curves it can be stated that the degradation process starts at a temperature of app. 132°C.



**Figure 1:** Temperature-dependent mass change (TG), rate of mass change (DTG, dashed line) and heat flow rate (DSC) of the sample BioCo1.

At the first stage in bio-polymer binder pyrolysis, the weak C-O-C and C-C bonds in the glycoside bond are decomposed. At the temperature range of 133-324°C, two exothermal effects due to the destruction of the organic part of the material are observed in sequence. Enthalpy value is estimated on 880 J/g. At 422°C, the TG/DSC curve shows the last mass loss (42%) accompanied by an exothermal effect (36 J/g). The remainder of the sample mass (approx. 24.7%) which has not decomposed up to the temperature of 600°C probably contains organics and inorganics (eg. carbonised carbon) found in the binder cross-linking by means of Ca(OH)<sub>2</sub> and CO<sub>2</sub>.

#### 4. Conclusions

The fragment of investigations related to the thermal stability of new foundry polymer binders with biopolymer fractions is hereby presented. A sample of the foundry binding agent BioCo1, in a form of two-component polymer composition consisting of a modified biopolymer (modified starch) and a synthetic polymer (acrylic polymer), was subjected to the thermal analysis. The binding agent behaviour at increased temperatures is important in relation to the process of the sand mould (with BioCo1 fraction) pouring with liquid metal. Methods of thermal analyses (TG/DTG/DSC) were applied in investigations in order to perform the thermal degradation process of the tested BioCo1 binder sample by establishing thermal effects of transformations, structural and masses changes - occurring during its heating.

#### Acknowledgements

*The work was supported by the Project AGH No 11.11.170.318/13.*

#### References

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