Bulgarian Chemical Communications, Volume 47, Special issue (pp.45 - 50) 2015

Investigation on the influence of chemical additives over the behavior of paper furnish from recycled newspaper fiber material

D.A. Todorova*, S.P. Bencheva

University of Chemical Technology and Metallurgy, 8 Kl. Ohridski, 1756 Sofia, Bulgaria

Received July 30, 2014; Accepted February 13, 2015

The use of secondary fibers from waste paper itself is a major trend in the production of various types of paper and cardboard, which has a very positive environmental effect; it saves water, electricity, steam and wood raw material. On the other hand the regenerated fibers have reduced sheet-forming-properties and induce problems by the appearance of so-called "stickies". These substances are undesirable components, since reduced and in some cases interfere with the action of the cationic chemical additives (CCA) added for a specific purpose. To solve these issues papermakers use CCA.

What is used primarily in the paper production processes are high-molecular weight hydrophilic synthetic polymers (polyelectrolytes) with different chemical nature. As a result, the dewatering is accelerated, the retention of the components in the paper sheet is improved and this provides a clarified white waters.

The purpose of this study was to investigate the effect of cationic synthetic polyelectrolytes with different chemical nature and charge over the behavior during the dewatering of paper furnish from recycled fiber material from waste paper.

The recycled fiber material is from waste newsprint paper and it mainly consists of chemical-thermo-mechanical pulp. Six types of cationic chemical additives with different chemical nature and charge density are used. The dewatering ability is measured and the turbidity and conductivity of the white waters is determined.

As a result of the studies carried out it is found out that for the improvement of the dewatering and for the clarification of the white waters, the most advisable is the usage of chemical additive based on polyacrylamide.

Key words: *chemicals additives, paper furnish, dewatering, white water, polyelectrolytes*

.

INTRODUCTION

Paper is one of the oldest and widespread industrial products of the world. It is an irrevocable part of everyday life in all its aspects. Fortunately, paper is an ecological product. Its main components are the renewable materials and used paper can be unfenced in natural conditions if it's not being used again for the production of recycled paper or some other method.

Modern paper technology is unimaginable without the use of a great amount of subsidiary materials and chemical additives (CA) as well. Added to the renewable materials they above all things form the necessary features of a paper sheet. With their help a number of technological problems are being solved and also they provide a possibility for saving raw materials when at the same time improving paper quality properties [1-3].

Nowadays the first place among raw materials for paper production takes waste paper which has a very positive environmental effect; it saves water, electricity, steam and wood raw material. On the other hand the regenerated fibers have reduced sheet-forming properties and induce problems by the appearance of so-called "stickies". These substances are undesirable components, since reduced and in some cases interfere with the action of the cationic chemical additives (CCA) added for a specific purpose. To solve these issues papermakers use CCA. One of the problems in using secondary fiber material is its lower drainage ability. This necessitates a specific selection of wet-end chemical additives in the composition of recycled papers [4-6].

What is used primarily in the paper production processes are high-molecular weight hydrophilic synthetic polymers (polyelectrolytes) with different chemical nature. Their role is to cause colloid-chemical changes at the barrier surface of the system "fiber-to-water", and especially the values of the electro-kinetic potential. The obtained larger and smaller agglomerates are better retained onto the web. As a result, the dewatering is accelerated, the retention

To whom correspondence should be sent.
E-mail: todorova.dimitrina@uctm.edu

of the components in the paper sheet is improved and this provides a clarified white waters.

Paper is definitely not a factor interfering with the ecological balance of the world. On the contrary - one of the reasons for that is because a basic requirement towards CA for the paper industry is their ecology – it is being put equally in the triangle "functionality - cost – ecology" [6]. What does this mean? The short answer is – to provide:

- Better utilization of resources – here comes into play the recycling process of waste paper and improved components retention;
- Greater economy of energy – this includes the intensification of refining, dewatering and drying;
- Purer waste waters, which include an improved water circuit with maximum use of white waters.

The behavior of paper furnish during dewatering basically depends on the type of fiber material and the degree of its beating (pulp, chemical pulp, waste paper), fillers, sizing agents and used chemical additives.

A fundamental goal in paper production has always been: to get a greater possible quantity of paper with the highest possible quality at the lowest expense possible all the while acknowledging the ecological requirements.

The purpose of this study was to investigate the effect of cationic synthetic polyelectrolytes with different chemical nature and cationic charge over the behavior during the dewatering of paper furnish from recycled fiber material.

EXPERIMENTAL

The investigations were carried out with secondary fiber material from waste newspaper, containing pulp and chemo-thermo-mechanical pulp (CTPM). The slushing of the paper was made in laboratory vertical pulper and the refining degree was 70 °SR. The objective is to disintegrate fiber slurry so that fibers are separated, wetted and are flexible before entering the chemical additives.

As a Chemical Additives (CA) for the investigation of the drainage ability were used six additives by four types of polymers – Polyacrylamide (PAA), Poly Amine (PA), Poly Ethylene Imine (PEI) and PolyDADMAC + PAA. Its characteristics are shown in Table 1. The consumption of the polymers is 0,025%, 0,05%, 0,075% and 0,1% from o.d.f.

During the process of production of CMP are For straightening out the interactions, the Kinetics of the drainage ability of the suspensions was determined, by Schopper Riegler method. The Dewatering time of paper furnishes were determined for 300ml, 400ml, 500ml, 600ml and 700ml, s.

White waters are also being studied:

- Turbidity – NTU nephelometric acc. ISO 7020 (Turb 350 IR);
- Conductivity - μS acc. ISO 7888 (conductometer EC215).

Measuring the electric conductivity gives an indication of the total concentration of electrolyte in the liquid phase.

RESULTS & DISCUSSION

Influence of the quantity and type of chemical additives, on the drainage ability of the suspensions from recycled fiber material. The accelerated dewatering and increased retention as a result of flocculants effect usually means purer waters in paper mill as well. We are going to present experimental data on the behavior of some CA with dewatering and flocculation effect in the structure of various fiber suspensions. The studies are conducted by products with different chemical nature, molecular weight, conductivity and cationic charge density (Table 1).

The above-mentioned CA are being added in quantity of 0.025% to 0.1% from o.d.f. to water suspensions of secondary fiber material.

The effect of the six examined CA on the drainage ability of suspensions can be presented with the change of dewatering time in seconds (Fig 1-6).

The CA in this case definitely improved the dewatering time, even at 0,025% consumption of

Table1. Characteristics of chemical additives.

	Characteristics of chemical additives			
	Chemical substance	Name	Cationic charge	Conductivity, μS
1.	Polyacryl amide (PAA)	Percol 178	+	61
2.	Polyacryl amide (PAA)	Percol 57	++	117
3.	Polyacryl amide (PAA)	Retaminol PCE-304L	+	73
4.	Poly Amine (PA)	Retaminol K	+++	343
5.	Poly Ethylene Imine (PEI)	Retaminol 2S	+++	410
6.	PolyDATMAC 50% + PAA 50%	Fenosil ES 128	++	174

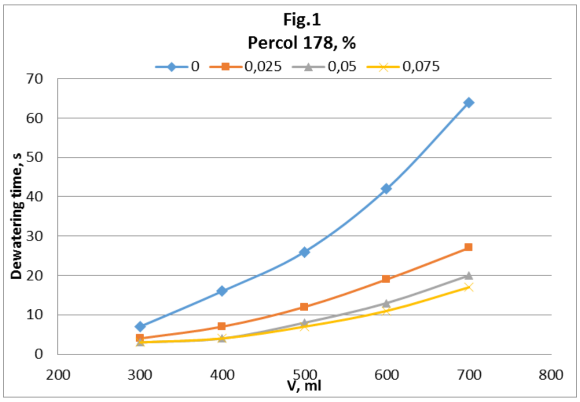

Fig. 1. Dewatering time of secondary fiber suspension at different Percol 178 consumption.

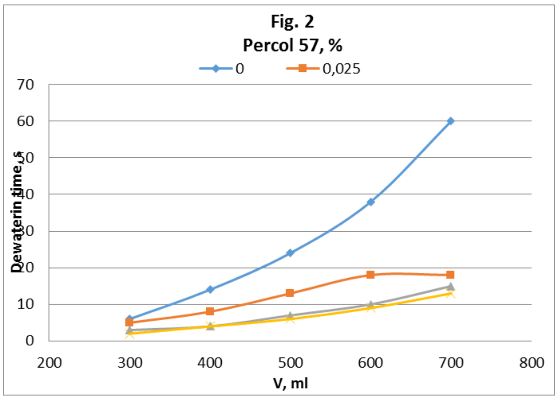

Fig. 2. Dewatering time of secondary fiber suspension at different Percol 57 consumption.

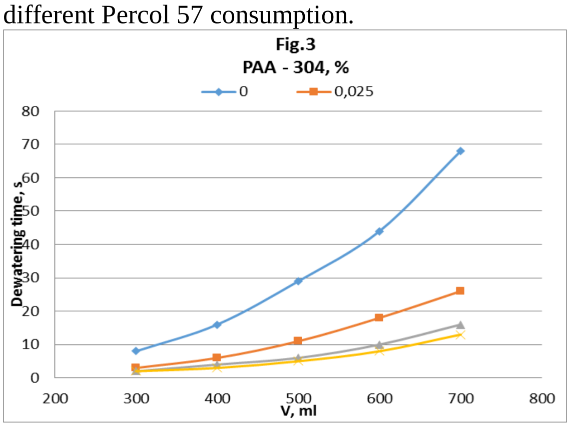

Fig. 3. Dewatering time of secondary fiber suspension at different PAA-304 consumption

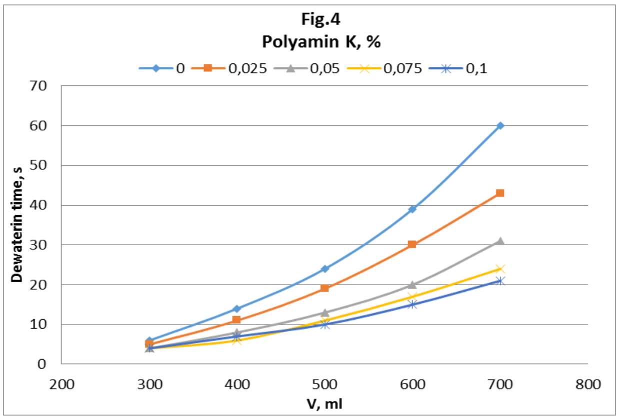

Fig. 4. Dewatering time of secondary fiber suspension at different Polyamin K consumption.

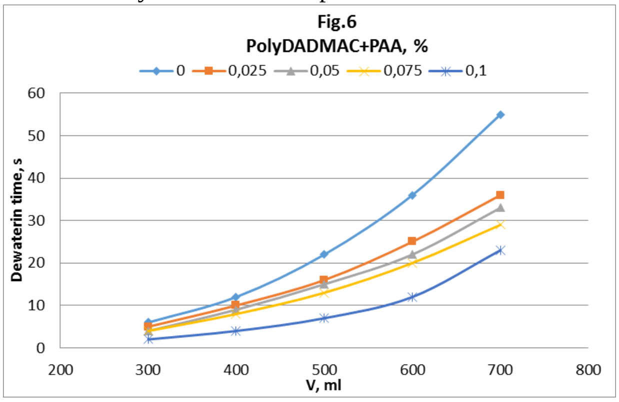

Fig. 6. Dewatering time of secondary fiber suspension at different PolyDADMAC+PAA consumption

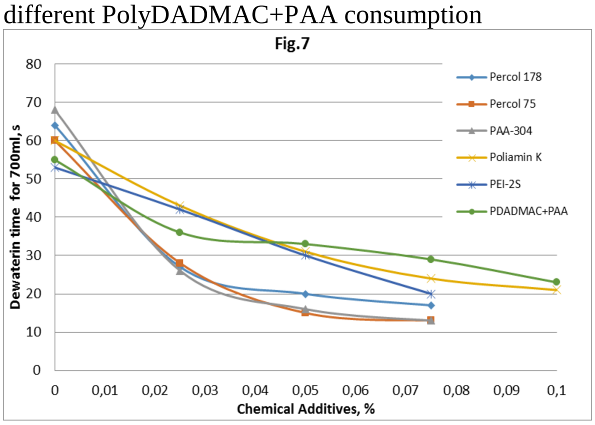

Fig. 7. Dewatering time for 700ml of secondary fiber suspension at different Polyelectrolytes consumption.

the polymers. The figures show that the PAA based CA (Percol 57, Percol 178 and PAA-304) have improved dewatering effect, compared to the other types of polymers (Polyamin K, PEI -2S, PolyDADMAC+PAA). The course of the curves is more uniform with the CA, compared with those without CA.

As it is well known, the cationic PAA are CA with higher molecular weight and lower charge density. They formed agglomerates "water-fibers-cationic-polyacrylamide", through the bridge-forming mechanism. As a result, in the web are formed larger free spaces, without small particles and fines, which results in better water flowing ability. The so- formed flocks are larger with friable structure (macro-flocculation) and the flocculation advanced the dewatering. With increasing the chemical additives, the flocculation capacity is enhanced. With increasing the charge density of the cationic CA, the dewatering is improved.

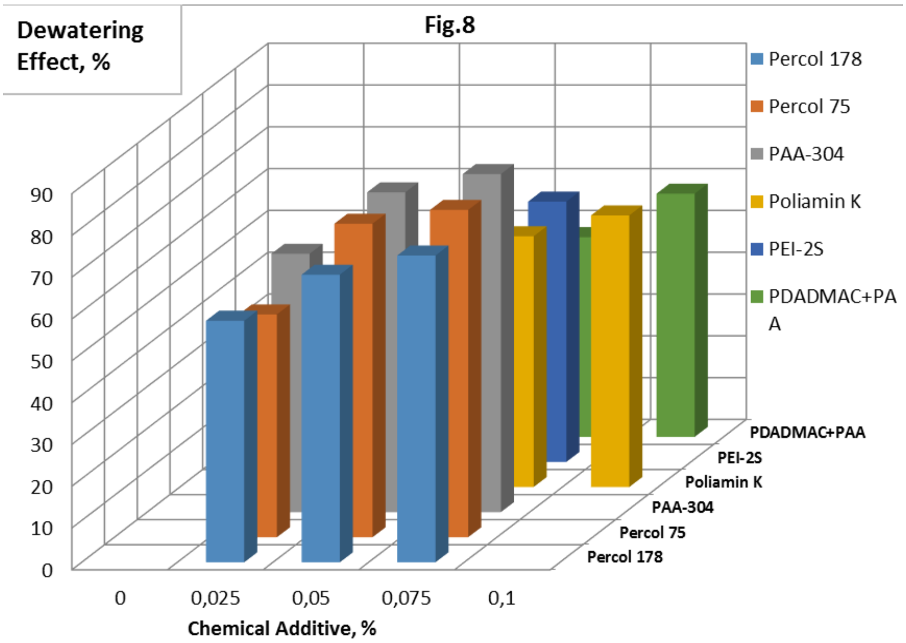

Fig. 8. Dewatering effect of secondary fiber suspension at different Polyelectrolytes and different consumption.

The dewatering effect with the other three CA, based on polyamine, poly ethylene imine and PolyDADMAC, is different and the mechanism of their effect is mainly by the mosaic bonding. They have lower molecular weight and higher charge density. The formed flocks are smaller in relatively compact structure – micro-flocculation.

The effect of the six examined CA on the Dewatering Effect of the secondary fiber suspensions can be presented with the change of dewatering in percentage, calculated with the value of dewatering time at 700 ml filtrate without (T^0_{700}) and in the presence (T_{700}) of certain quantity of chemical additive:

$$Dewatering\ effect = (T^0_{700} - T_{700}) / T^0_{700} .100,\ \%$$

The obtained experimental results are shown in Fig.8. It can be seen, that PAA-304, at 0,05% consumption, has the highest dewatering effect – 76%. From the other types of CA, the PEI-2S at the same consumption has 43,4% dewatering effect. The CA in this case definitely improved the drainage. According to their dewatering effects at 0,05% consumption, they are being sorted by the nature of the polymers, i.e. the cationic PAA have a better effect: PAA-304 > Percol 57 > Percol 178 > Polyamine K > PEI-2S > PolyDADMAC+PAA.

Influence of the quantity and type of chemical additives, on the properties of the white waters. The investigated secondary fiber material mainly consists of chemo-mechanical pulp, which is a precondition for the appearance of stickies. By the increased mechanical treatment they accumulate more. One of the ways to investigate this process is by measuring the turbidity of the white waters, shown on Fig.9. As it’s visible, chemical additives based on cationic PAA, gives the clearest white waters. The other three types are less effective for the clarity of the white waters and with increasing the CA consumption the clarity decreased.

The effect of the six examined CA on the clarification ability of the secondary fiber suspensions can be presented with the change of clarification effect in percentage, calculated with the value of clarity at 700 ml filtrate without (NTU^0_{700}) and in the presence (NTU_{700}) of certain quantity of chemical additive:

$$Clarification\ Effect = (NTU^0_{700} - NTU_{700}) / NTU^0_{700} .100,\ \%$$

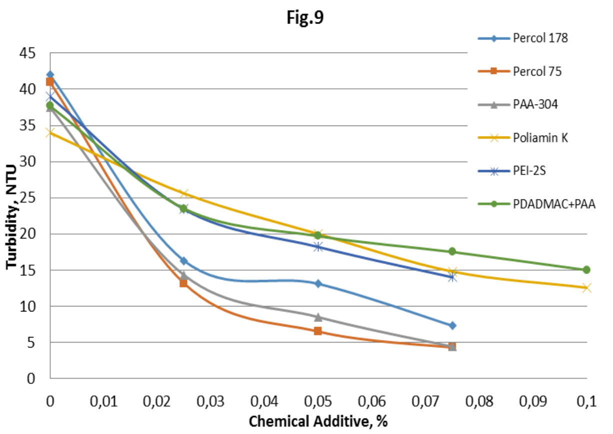

Fig. 9. Turbidity of secondary fiber suspension white waters at different Polyelectrolytes consumption.

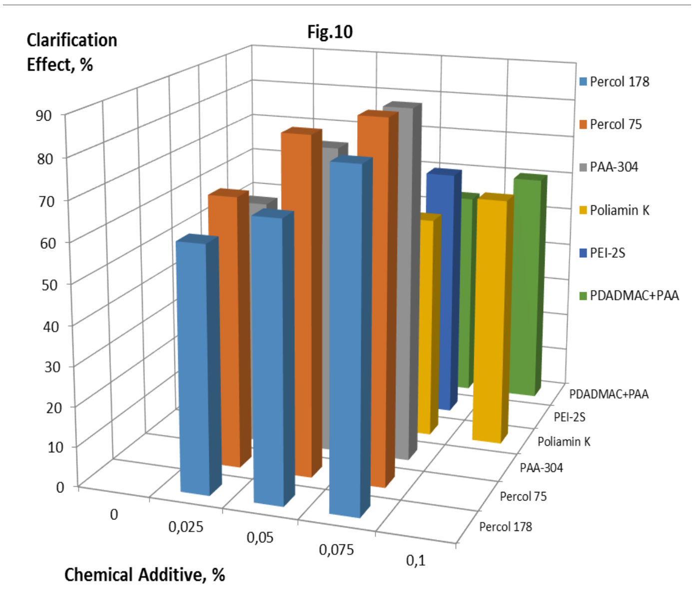

Fig. 10. Clarification effect of secondary fiber suspension at different Polyelectrolytes and different consumption.

Table 2. Conductivity of the white waters.

Conductivity, μS						
Consumption, %	Percol 178	Percol 75	PAA-304	Polyamin K	PEI-2S	PolyDADMAC+PAA
0	152	150	148	146	145	146
0,025	151	149	148	145	145	145
0,05	150	149	148	145	144	144
0,075	150	149	147	145	144	144
0,1				145		143

Fig.10 shows the clarification effect for the sixth investigated polymers at the certain consumption. The highest clarification effect - 84% has the Percol 57 at 0,05% consumption, while with PEI-2S, at the same consumption the clarification effect is 53,4%. The worse effect, at 0,05% consumption, gives the Polyamin K – 41,8%.

The investigations carried out show that for the waste newspaper recycled suspensions the PAA based polymers are particulate, in spite of their low cationic charge. The advisable consumption for the PAA based polymers is from 0,025% to 0,05% from o.d.f., but for the other three types is from 0,05% to 0,075% from o.d.f.

The results for the conductivity of the white waters, shown in Tabl.2 present that with increasing the Percol 178, Percol 57, PAA-304 and PolyDADMAC+PAA consumption, the conductivity parameter decreases. Measuring the electric conductivity gives an indication of the total concentration of electrolyte in the liquid phase. The quantity of the fines in the white waters decreases, because of the enhanced flocculation and retention.

CONCLUSIONS

The obtained experimental results show, that for the acceleration of the dewatering ability of secondary newspaper fiber material, it is appropriate to use chemical additives, based on Polyacrylamide at a consumption of 0,025 ÷ 0,05% from o.d.f.

For enhancing the clarity of the white waters from recycled fiber material it is necessary to use Wet-End chemical additives based on Polyacrylamide.

By its action on accelerating the drainage of the secondary fiber material and the clarification of white water, the studied out chemical additives, used in amount 0.05% from o.d.f. are being sorted by their dewatering and clarification ability, in the following orders:

Dewatering ability:

PAA-304 > Percol 57 > Percol 178 > Poliamin K > PEI-2S > PolyDADMAC+PAA

Clarification ability:

Percol 57 > PAA-304 > Percol 178 > PEI-2S > PolyDADMAC+PAA > Poliamin K.

REFERENCES

1. L. Wagberg, L. Winter, Papermaking chemicals and their function. In: Applications of Wet-End Paper Chemistry, Au C.O., Thorn I. (Eds.), Blackie Academic & Professional, Glasgow, 1-11, (1995).
2. R. Isermann, *Wochenblatt f. Papierfabrikation*, **131**, 629 (2003).
3. M. Soeffge, *Wochenblatt f. Papierfabrikation*, **131**, 28 (2003).
4. J. Gullichsen, H. Paulapuro, "Papermaking Chemistry", TAPPI PRESS, 1999.
5. J. Casey, "Pulp and paper Chemistry and Chemical Technology", Volume III, 1979, USA.
6. S. Kleemann, *IPW / Das Papier*, Nr. 9, 31, (2003).
7. P. Rosenthal, *Wochenblatt f. Papierfabrikation*, **119**, 951 (1991).

ИЗСЛЕДВАНЕ ВЛИЯНИЕТО НА ХИМИЧЕСКИ СПОМАГАТЕЛНИ ВЕЩЕСТВА ВЪРХУ ПОВЕДЕНИЕТО НА СУСПЕНЗИЯ ОТ РЕЦИКЛИРАН ВЛАКНЕСТ МАТЕРИАЛ ОТ ВЕСТНИЦИ

Д.А. Тодорова*, С.П. Бенчева

Химикотехнологичен и металургичен университет, София 1756, бул. Климент Охридски №8

Постъпила на 30 юли, 2014 г.; приета на 13 февруари, 2015 г.

(Резюме)

Използването на вторични влакна от отпадъчна хартия се налага като основна тенденция при производството на различни видове хартии и картони, което има изключителен положителен екологичен ефект, спестява разходи на вода, на електрична енергия, пара и дървесна суровина. От друга страна регенерираните влакна имат понижени листообразуващи свойства и създават проблеми, причинени от появата на т.н."пречещи вещества". Тези вещества са нежелателни компоненти, тъй като редуцират, а в някои случаи смущават действието на катионните химични спомагателни вещества /ХСВ/, добавени с определена цел. За решаването на тези въпроси се използват ХСВ.

Основно се използват високомолекулни хидрофилни синтетични полимери /полиелектролити/ с различна химична природа. В резултат на тяхното действие се ускорява отводняването, подобрява се задържането на компонентите в хартиения лист и се осигуряват по-бистри подситови води.

Целта на настоящото изследване е да се изучи влиянието на катионни синтетични полиелектролити с различна химична природа и заряд върху поведението при отводняване на суспензия от рециклиран влакнест материал от отпадъчна хартия.

Рециклираният влакнест материал, с който се осъществяват експериментите е от отпадъчна вестникарска хартия. При провеждането на изследванията са използвани различни по своята химична природа катионни синтетични полиелектролити, различаващи се по молекулна маса и плътност на заряда.

В резултат на проведените изследвания се установи, че за подобряване на отводняването и за избистряне на подситовите води, най-целесъобразно е използването на ХСВ на основата на полиекриламид.