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Effects of Alum-Rosin Sizing on the Properties of Some Wastepaper Grades*

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Abstract: Waste paper is one of the most feasible raw materials for the pulp and paper industry in Turkey as well as in many other countries. However the utilisation process is not so easy. Problem starts from the collection, consumers, transportation, classification and goes to the pulping strategy and production with chemical addition. The composition of waste papers used in the paper production greatly varies from time to time and the location from which it is collected. This creates a great concern at the mills from the fact that the production quality inevitably changes and fluctuates. In such situation, the production has to be monitored very closely and parameters should be modified very fast if something occurs. This research is concentrated on the investigation of interactions between the acidic internal sizing agent and four waste paper grades. Handsheets were made from each waste paper groups with alum-rosin addition as an internal sizing agent. Papers were tested firstly for water resistance and some other standard properties. Results showed that the interactions between the chemical added and the waste paper groups used here were significantly different. This suggests that chemical addition points, order, dosage and contact time should be prescribed differently for each group of waste papers instead of pumping in a mixed stock as common practice.

Key words: Paper recycling, alum-rosin sizing, cobb, handsheet, internal sizing

INTRODUCTION

Paper industry in Turkey has been struggling for many years to overcome the raw material problem. Basically forests, annual plants and waste papers are the main recourses which could feed the hungry pulp and paper mills in Turkey as well as in the other part of the world. Since Turkey is not a forest rich country, paper industry has to turn her face to the annual plants and waste paper. Regarding waste papers circulated in the market, around 1 million tonne is currently recycled in a year. Waste paper collection rate and utilization figure should be definitely increased (Karademir *et al*., 2002; Tutuş and Karademir, 2002).

In the recycling paper mills it is quite difficult to achieve a standard performance for any additives. The main reason arises from the fact that the raw material, waste paper itself, contains a variety of many different used papers. Depending on the final paper to be produced in the mill, certain combinations of waste papers are mixed and a standard paper is tried to be made. To be able to do this in an acceptable range, engineers use some chemicals, additives and dyes as well as playing with the machine parameters. Even though nobody can in fact guarantee that the chemicals or other additives could help produce standard papers at all time. Therefore problems with retention, paper strength, web breaks, drying and those with sheet properties could be experienced in many cases. Especially web breaks due to the poor paper strength and/or higher moisture content in traveling sheets (due to the slower drying rate) lead to the higher downtimes which creates big operational costs (Hawes and Doshi, 1994; Retulainen *et al*., 2002). Depending on the stock combination and ingredients, some poor and/or non-uniform reactions with added chemicals could be faced. The economical and the practical solutions to such problems are one of the main concerns in the industry (McKinney, 1995; Turvey, 1995).

Water resistance against to the penetrating liquids (such as water, ink, milk etc.) is required for a wide range of paper products. The sizing is the term which defines the processes practiced to give a paper such property. While the former is commonly known as internal sizing, the latter is called as surface sizing (Robert, 1996). Rosin-alum internal sizing methods is probably the most known and practiced sizing methods for many years. Commercial rosin is a glassy, amorphous material which melts down at 75 to 95°C and can be obtained from tall oil, wood and gum. Rosin size is normally prepared by reacting rosin with aqueous alkali (NaOH) (saponification) and added to

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stocks with papermakers alum ($Al_2(SO_4)_3.18H_2O$). Method is extremely sensitive to pH and works best at pH between 4.5 to 5.5 (Roberts, 1996; Otway and Johnson, 1995).

In this research, alum-rosin internal sizing application was practiced on waste papers classified in four main groups as office paper, old corrugated, magazine and newspaper and produced handsheets were tested to analyze the differences.

MATERIALS AND METHODS

Waste papers were classified in four main groups as office paper, old corrugated, magazine and newspaper which were used as secondary fibre resources throughout this experiment. Waste paper samples were soaked in tap water overnight and then disintegrated using a laboratory disintegrator. Standard laboratory handsheets were evaluated in a British Standard handsheet machine at a grammage of 150 g m^{-2}. Handsheets were then air dried using drying rings and conditioned in a climate controlled air conditioned room at 23±2°C and 50% RH, for at least two days prior to testing.

Alum-rosin sizing was used at addition levels of 0.5, 1.0, 1.5, 2.0 and 2.5% on oven-dry fibre as an internal sizing agent. Alum and rosin sizing emulsion (Topsize RD 44) used in this work were supplied by KM Paper Mill, Kahraman Maras, Turkey and products specifications were given in Table 1.

Handsheets produced were tested to determine for ash content, burst, tear, tensile index, cobb and air permeability properties according to relevant international standards.

RESULTS AND DISCUSSION

Pulp properties: Pulps prepared for each waste paper had different freeness degrees as revealed by Shopper Riegler (SR°) test and observed when handsheets were being formed. Values obtained were 50, 40, 80, 60 SR° for office paper, old corrugated, magazine and newspaper respectively. Some pulps required remarkably longer time to settle down on the wire of the handsheet cylinder. Since the pulps tested were containing some other paper maker additives, freeness results could not be just assessed according to only the fibre qualities. As known SR test can not completely give features of the fibres in pulp but actually helps estimating the situation. One, for instance, can not be sure if a stock consists of mainly shorter fibres by just looking at the SR° value. But what is accepted is that beaten and fibrillated fibres tend to hold water more and drainage would take some more time compared to the unbeaten fibres. Also any small ingredients in the stock such as, fines, small fibre brokes and fillers naturally increase the drainage time. In such cases, either the speed of the paper machine has to be slowed down or/and extra vacuuming should be installed at the forming part of the machine. The retention becomes extremely important phenomena if the content of small particles in a stock is high (Karademir *et al.*, 2005).

Table 1: Features of rosin sizing emulsion and papermaker alum supplied by KM Paper Mill

Sizing agent	Parameters	Specification
Rosin sizing	Dry matter as w/w (%)	40.52
	Density at 20°C (g cm^{-3})	1.04
	pH unit at 20°C	6.21
	Viscosity (mPa s)	13.80
Papermaker alum	Al_2O_3 (%)	16.12
	Fe_2O_3 (%)	0.03
	Non-water soluble (%)	0.30
	pH unit at 20°C	2.50
	Density (g cm^{-3})	1.70

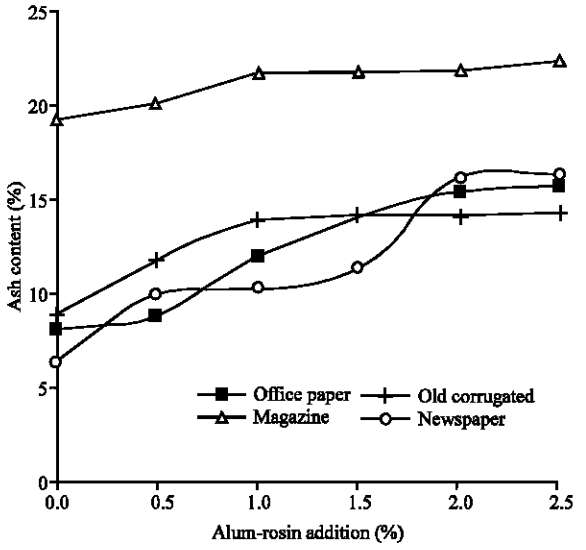

Fig. 1: Ash content and increases in retention with sizing chemicals

As shown in Fig. 1, the ash content of magazine waste papers was significantly higher from that of others. Magazine papers due to their end use requirements can sometimes contain fillers (mainly clay) up to 30% on oven-dry fibre. Ash contents for all papers increased with alum-rosin additions indicating that sizing chemicals used, especially alum improved the retention. Higher ash content, SR° values with parallel to extremely higher formation time and increased retention were a good agreement supporting each other. Papermaker alum due to its functional charged sites is known to increase the retention.

Air resistance were measured with a Gurley device where the time second required for 100 mL air to pass a 645 mm^2 circular area on a paper under a certain pressure

were recorded. Result (Fig. 2) seems to be in a very close agreement with ash result. Magazine paper was found to have a highest air resistance. It was attributed to the highest ash content of the sheets and well-compact formations. The rest accumulated in a similar range, where newspaper showed little improvement. Again it is clearly seen that sizing chemicals improved the retention hence air resistance of the recycled handsheets.

Improvements on water resistance: Papers water resistance values were noted to be increased with the increasing alum-rosin addition. Cobb values for magazine recycled handsheets were seen to be decreasing at a slower rate compared to others (Fig. 3). This can be attributed to the highest ash content of sheets, meaning the fillers and also coating ingredients. Since magazine papers contained around 20% filler, it is perfectly reasonable to expect this paper to be sized little bit difficult. Previous works revealed that any small particles, fines and fillers present in pulp slurry definitely increase the demand of sizing chemicals and others such as dry strength and retention chemicals (Karademir *et al*., 2005). Sharpest increase in water resistance as a result of chemical addition was witnessed for office paper and corrugated samples. This is assumed to be probably due to the lower total surface area of pulps compared with newspaper. Newspapers are normally made from mechanical pulps with moderate beating.

Mechanical pulps due to more functional groups on their surface tend to absorb more chemicals. As known any chemical applications to wood fibres by means of cooking and/or bleaching processes can inevitably cause the extraction of some wood components to some extent (Robert, 1996). Mechanical pulps in this respect would contained, in addition to cellulose, almost all wood components and cell wall materials like, hemicelluloses, lignin and other polymers more then any other even mildly cooked chemical pulps (Stationwala *et al*., 1996; Ölander *et al*., 2005). This may be probably the reason that the sizing was not improved in newspaper between the level of 0.5 to 1.5% alum-rosin addition. At this range, chemicals added were believed to be taken up by the functional groups on beaten mechanical pulps. Ones these surfaces were fully covered, the development on sizing of newspaper were observed.

Improvements on paper strength: Overall alum-rosin addition significantly increased the sheet's strengths. Handsheets made from newspaper and magazine papers gave the highest breaking length as seen in Fig. 4. Office paper and corrugated papers had similarly shorter breaking length. Mechanical fibers in newspaper were believed to be responsible for the higher breaking length.

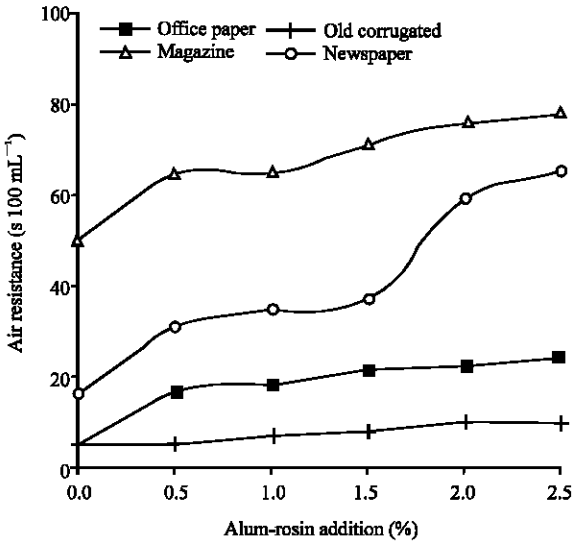

Fig. 2: Air permeability of handsheets made from recycled paper

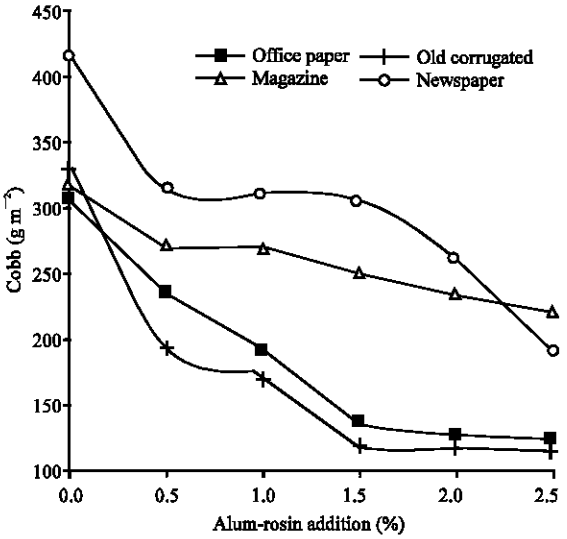

Fig. 3: Alum-rosin addition improving the papers water resistance values

One may think that it is surprising that the magazine papers were found to be having the longer breaking length despite the highest ash content (Fig. 4). It is normal to think that way as in general it is believed that any filler content present in a paper matrix definitely interferes the interfiber bonding to some extent, hence reduces the paper strength (Hawes and Doshi, 1994; Nazhad *et al*., 2003). Nevertheless, the other chemicals and paper additives retained such as some binders, dry strength additives and most probably starch must be taken into the consideration. Magazine papers normally contain such

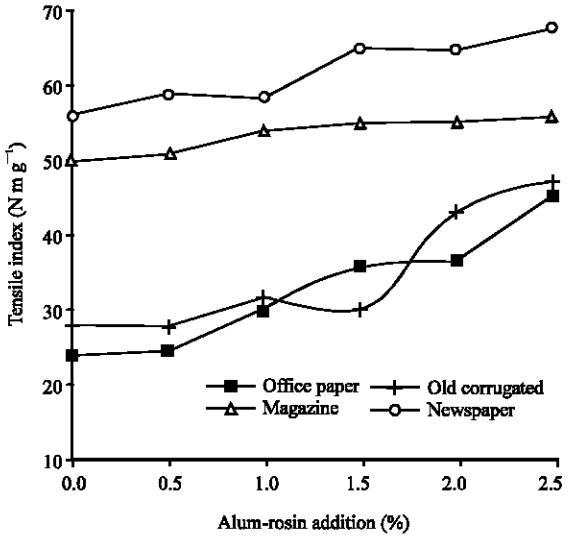

Fig. 4: Alum-rosin addition improving the tensile index

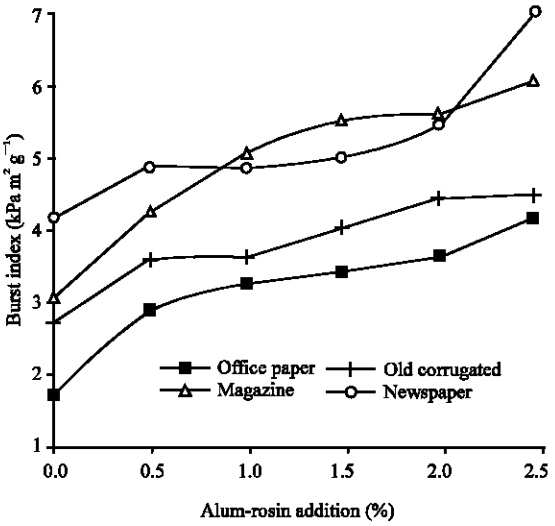

Fig. 6: Burst index of alum-rosin added handsheets

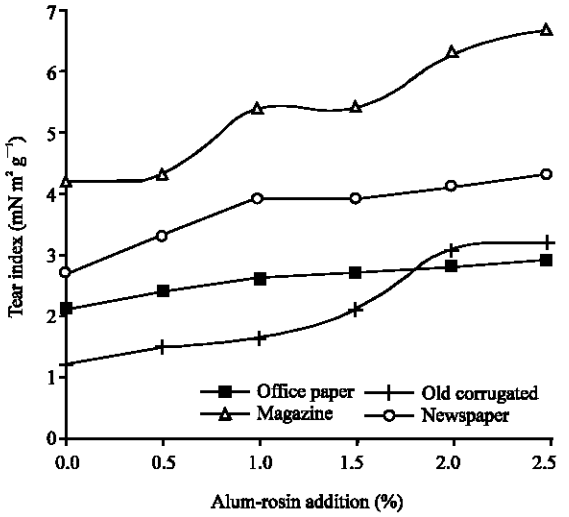

Fig. 5: Effects of alum-rosin addition on the tear index

materials and these were assumed to have contributed to the paper strength. Furthermore, recently it was reported that despite the general believes, fines and small fibres were actually helping especially the strength of filler-loaded papers (Xu and Pelton, 2005). If it was so, then similar mechanism might have worked better here with the help of strength (bonding) enhancing chemicals which were originally present in the coating mixture.

Results obtained from both the tear index and the burst strength tests were in similar orders as that of the breaking length test as seen in Fig. 5 and 6, respectively. As paper strength strongly depends on the strength of individual fibre strength and the strength of fibre-fibre bondings (Page, 1969; I'Anson *et al*., 2006), results should be discussed in this respect. Even without alum-rosin addition, both recycled magazine and newspaper handsheets were noticeably stronger then other two, namely corrugated and office paper. This indicates that both the stronger fibers and interfiber bondings were actually present in these two superior handsheets. Especially in the magazine papers, as discussed above, other coating ingredients were believed to make a good contribution to papers strength.

Inter fibre bonding area and strength were reported to be closely related to the total surface area of a pulp and the good sheet formations (Clarke *et al*., 1985; I'Anson *et al*., 2006). Both the air permeability and the cobb tests confirmed that especially pulps made from the recycling of magazine papers and newspapers were having larger surface areas than other two and produced well compact handsheets (Fig. 2 and 3). Having a larger surface area leaded to the slower development of Cobb values (Fig. 3) and good formations resulted in denser sheets having higher air resistance values (Fig. 2). Results suggested and confirmed that relative contact areas in handsheets made from magazine and newspaper were higher then others made from corrugated and office papers. Therefore it was believed that the interfiber bonding strengths were higher in these aforementioned two handsheets and this was thought to be the main reason of higher strength properties.

CONCLUSIONS

Following conclusions could be extracted from this study:

- Waste papers differ greatly from each other due to the properties of their different fibre contents and also other papermaker additives.
- Same level of alum-rosin additions created different changes on the properties of papers tested here.
- The higher ash content gave denser sheets and reduced the sizing development due to probably the bigger surface area.
- Alum-rosin addition in general increased the retention, improved the water resistance and enhanced the strength properties of handsheets.
- The increase in the relative bonded area promoted the relative bond strength and generated stronger handsheets.
- It will help greatly to the assessment of results if all ingredients in each set of waste papers are determined in quantity and quality.

Overall, it should be said that due to the variability of even classified waste papers, extra attention should be given to the addition point, level and type of papermaker additives if any disturbing variables on final paper properties are to be totally diminished.

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REFERENCES

Clarke, B., K.I. Ebelling and H.W. Kropholler, 1985. Fibre coarseness: A new method for its characterisation. Paperi ja Puu, 67: 491-496.

Hawes, J. and M. Doshi, 1994. The Contribution of Different Types of Fines to the Properties of Handsheets Made from Recycled Paper. In: Recycled Paper Technology. An Anthology of Puplished Papers. Doshi, M. (Ed.), TAPPI Press, pp: 253-262.

I'Anson, A.J., A. Karademir and W.W. Sampson, 2006. Specific contact area and the tensile strength of paper. Appita J., 59: 297-301.

Karademir, A., S. Imamoglu and A. Tutus, 2002. Situation of paper-based waste in Turkey. Proceeding of International Waste Management Association (ISWA) Conference, 1: 419-427, Istanbul, Turkey.

Karademir, A., Y.S. Chew, R.W. Hoyland and H. Xiao, 2005. Influence of fillers on sizing efficiency and hydrolysis of alkyl ketene dimmer. Can. J. Chem. Eng., 83: 603-606.

McKinney, R.W.J., 1995. Wastepaper Preparation and Contamination Removal. In: Technology of Paper Recycling. McKinney, (Ed.), Blackie Academic and Professional, pp: 48-124.

Nazhad, M.M., W. Karnchanapoo and A. Palokangas, 2003. Some effects of fibre properties on the formation and strength of paper. Appita J., 56: 61-65.

Ölander, K., M. Htun and U. Gren, 2005. Specific surface area. An important property of mechanical pulps. J. Pulp Pap. Sci., 20: 147-152.

Otway, P. and D.C. Johnson, 1995. Sizing in acid, neutral and alkaline conditions. In: Applications of Wet-End Paper Chemistry, Blackie Academic and Professional, pp: 139-170.

Page, D.H., 1969. A theory for tensile strength of paper. Tappi J., 52: 674-678.

Retulainen, E., K. Luukko, K. Fagerholm, J. Pere and J. Laine, 2002. Papermaking quality of fines from different pulps. The effect of size, shape and chemical composition. Appita J., 55: 457-460.

Roberts, J.C., 1996. Paper Chemistry, Roberts, J.C., (Ed.), Blackie Academic and Professional, pp: 140-150.

Stationwala, M.I., J. Mathieu and A. Karnis, 1996. On the interactions of wood and mechanical pulping equipment. Part II: Pulp quality. J. Pulp Pap. Sci., 22: 202-207.

Turvey, R.W., 1995. Chemicals used in Recycling. In: Technology of Paper Recycling, McKinney, (Ed.), Blackie Academic and Professional, pp: 130-153.

Tutuş, A. and A. Karademir, 2002. Pulp and paper production from the agricultural wastes generated in the southeast region of Turkey (GAP), Proceeding of IV Engineering Conference, pp: 1327-1332, Şanliurfa, Turkey.

Xu, Y. and R. Pelton, 2005. A new look at how fines influence the strength of filled papers. J. Pulp Pap. Sci., 31: 147-152.