ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 4 , April 2021

Investigation of the Effect of the Concentration of Carboxymethyl Cellulose on the Physical and Mechanical Properties of Paper

Sh.Yuldoshov, J.J. Ergashova, I.T.Bokieva

Phd, ICHPP AS RUz
Graduate student, TITLI
Graduate student, TITLI

ABSTRACT:. The influence of the concentration of carboxymethyl cellulose on the physical and mechanical properties of paper has been investigated. Cotton, wood, straw pulp and MS-2 waste paper, as well as their compositions with a grinding degree of 350ShR, were used as a raw material for paper casting. It was found that with an increase in the concentration of carboxymethyl cellulose in paper pulp from wood, cotton cellulose, MC-2, as well as their various compositions, the physical and mechanical properties pass through a maximum.

Thus, it was found that the addition of a certain amount of CMC in the composition of paper, depending on the types and composition of raw materials, leads to an increase in the physical and mechanical properties of the final product.

KEY WORDS: carboxymethyl cellulose, paper, raw materials, quality indicators**.**

I.INTRODUCTION

Carboxymethyl cellulose (CMC), also called tylose, valocel, blanose, as well as ediphas, polycell and carbocel, is an amorphous white substance with weak acid properties [1]

CMC was first synthesized in 1918; its industrial production was mastered at the beginning of 1920 in Germany (2).

The world production of CMC is 47% of the total volume of produced cellulose ethers, and according to various sources, the world production of CMC today ranges from 180 to ~ 300 thousand tons / year (3).

Some scientific works are aimed at obtaining technical grades of CMC with specified physicochemical and operational properties. In this series, to obtain CMC with high transparency of solutions and a uniform distribution of substituents, the processes of cellulose mercerization and carboxymethylation are carried out under the action of ultrasound (4).

Over the past decades, work has been carried out to improve existing technological processes, expand the brand assortment of CMC and use more efficient apparatus for carrying out the carboxymethylation process. Work in these areas was carried out in Russia, the USA, Japan, Poland, Romania and Germany. In recent years, significant work has been carried out in the PRC (5).

Currently, Na-CMC is widely used in the following areas:

- in the oil and gas production and mining industry, textile production, in the production of detergents, ceramic products and as wallpaper adhesives (6).

To give the paper some specific properties, various types of sizing agents are used, which impart water resistance to the paper, as well as those that bind fibers together in a paper sheet and thereby contribute to an increase

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 4 , April 2021

in the tightness and mechanical strength of the paper, the former are called hydrophobizing, and the latter are called sizing binders. substances [7].

To increase the efficiency of sizing, as well as to increase the strength properties of paper in the technological process, binder sizing materials are used, which include: cellulose derivatives, carboxymethyl cellulose.

The paper sizing process begins when the glue is introduced into the water-fiber suspension and ends in the drying section of the paper machine. Consequently, starting from this moment and ending with the receipt of finished products, this process is subject to the active influence of many technological factors. Sizing materials and coagulants introduced into the colloidal-chemical system at the same time have a great influence on practically all properties of this system, i.e. themselves act as a disturbing factor [8].

The addition of CMC to the composition of paper, depending on the type, nature, production methods, quality indicators and concentration, significantly increases its physical and mechanical properties. Based on the properties of the initial raw material, it is required to determine the grade and concentration of CMC in the composition of the paper [9].

We have studied the effect of the CMC concentration on the physical and mechanical properties of paper. Cotton, straw, wood, waste paper (grade MS-2) and their compositions with a grinding degree of 350ShR were used as a raw material for casting paper.

By increasing the concentration of CMC in the composition of paper obtained from wheat straw, the physical and mechanical parameters go through a maximum. The maximum strength of straw paper is achieved with the addition of 0.75% CMC. At the same time, the tensile strength and rupture length of the sample are 3% and 72 kgf / cm2, respectively. In this case, the tensile strength and rupture length of the sample without the addition of CMC are 2.24% and 69 kgf / cm2, respectively.

Table 1
Influence of CMC concentration in paper obtained from wheat straw cellulose on physical and mechanical properties of paper.

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Straw cell. 100%	21,1	2,1	0,370	10	0,037	57	2,11
	32,4	2,8	0,400	10	0,040	81	2,38
	26,7	2,4	0,385	10	0,0385	69	2,24
Straw cell. + 0.37% CMC	19,2	3,27	0,500	10	0,050	38,4	3,27
	22	3,17	0,480	10	0,048	45,8	3,17
	20,6	3,22	0,490	10	0,049	42	3,22
Straw cell. + 0.75% CMC	24,5	3,53	0,320	10	0,032	76	3,53
	25,5	2,54	0,375	10	0,037	68	2,54
	25	3	0,347	10	0,034	72	3
Straw cell. + 1.1% CMC	32,4	2,85	0,340	10	0,034	95	2,85
	29,6	2,42	0,380	10	0,038	78	2,42
	31	2,6	0,360	10	0,036	86	2,6

It was found that when adding 0.75% CMC to wood pulp paper, its physical and mechanical properties, i.e. the tensile strength and length of rupture of the sample reaches up to 3.2% and 167.8 kgf / cm2. At the same time, the tensile strength and rupture length of the sample without the addition of CMC is 3.2% and 111.2 kgf / cm2, respectively.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 4 , April 2021

Table 2
The influence of the concentration of CMC in paper obtained from wood pulp on the physical and mechanical properties of the paper.

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Wood cell. 100%	34,2 33,4 33,8	3,4 3,01 3,2	0,300 0,308 0,304	10 10 10	0,030 0,030 0,030	114 108 111,2	3,4 3,01 3,2
Wood cell. + 0.37% CMC	36,2 36,3 36,2	2,96 2,98 2,97	0,340 0,350 0,345	10 10 10	0,034 0,035 0,034	106,4 103,7 104,9	2,96 2,98 2,97
Wood cell. + 0.75% CMC	54 48 51	3,3 3,1 3,2	0,298 0,310 0,304	10 10 10	0,029 0,031 0,030	181,2 154,8 167,8	3,3 3,1 3,2
Wood cell. + 1.1% CMC	55 56 55	3,6 2,7 3,1	0,290 0,250 0,270	10 10 10	0,029 0,025 0,027	189,6 224 203,7	3,6 2,7 3,1

Table 3
The influence of the CMC concentration on paper obtained from cotton cellulose on the physical and mechanical properties of the paper.

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Cotton whole.100%	84,3 68,7 76,5	4,46 2,6 3,53	0,280 0,290 0,285	10 10 10	0,0280 0,0290 0,0285	301 236 268,5	4,46 2,6 3,53
Cotton whole and 0.37% CMC	31 31,6 31,3	2,89 2,89 2,89	0,200 0,205 0,205	10 10 10	0,02 0,0205 0,02	155 154 154,5	2,89 2,89 2,89
Cotton whole and 0.75% CMC	43 38 40,5	7,95 6,95 7,45	0,190 0,200 0,195	10 10 10	0,0190 0,020 0,0195	226 190 207	7,95 6,95 7,45
Cotton whole and 1.1% CMC	94,3 72 83,1	6,9 7,1 7	0.240 0.260 0.250	10 10 10	0.024 0.026 0.025	392 277 332	6.9 7.1 7

An increase in the CMC content in cotton cellulose paper to 1.1% significantly increases the strength properties and the elongation is 7% and the break length is 332 kgf / cm2. At the same time, the tensile strength and rupture strength of the sample without the addition of CMC is 3.53% and 268.5 kgf / cm2, respectively.

The optimal values of the physical and mechanical properties of paper obtained from waste paper of the MS-2 brand are achieved with the addition of 1.1% CMC. At the same time, its strength indicators increase: the effect on elongation is 3.3% and the break length is 142.9 kgf / cm2. At the same time, the tensile strength and rupture length of the sample without the addition of CMC is 3.2% and 105.3 kgf / cm2, respectively.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 4 , April 2021

Table 4

Influence of CMC concentration on physical and mechanical properties of paper obtained from MS-2 waste paper.

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Waste paper brand MC-2 100%	29 27 28	2,97 3,4 3,2	0,240 0,293 0,266	10 10 10	0,024 0,029 0,021	120,8 92,1 105,3	2,97 3,4 3,2
Waste paper of the brand MC-2 + 0.37% CMC	28 35 31,5	3,2 3,4 3,3	0,220 0,250 0,235	10 10 10	0,022 0,025 0,023	127,3 140 134	3,2 3,4 3,3
Waste paper of the brand MC-2 + 0.75% CMC	27 29 28	2,7 2,8 2,7	0,220 0,220 0,220	10 10 10	0,022 0,022 0,022	122,7 131,8 127,3	2,7 2,8 2,7
Waste paper of the brand MC-2 + 1.1% CMC	37 32 35	3,5 3,9 3,7	0,230 0,260 0,245	10 10 10	0,023 0,026 0,024	160,8 123,1 142,9	3,5 3,9 3,7

For further study of quality indicators, papers were obtained from composite raw materials with different ratios, such as a composition from waste paper of the MS-2 brand and wood pulp with ratios of 50: 50.75: 25.25: 75. The addition of 0.37% CMC obtained from equal ratios of MS-2 waste paper and wood pulp improves its quality indicators, i.e. tensile strength is 3.7% and for a rupture length of 250 kgf / cm2. At the same time, without adding CMC to the composition of the paper, the tensile strength is 3.4%, and the tensile strength is 175.7 kgf / cm2

Table 5

Waste paper and wood pulp grade MS-2

Influence of CMC concentration on the composition of paper obtained in a 50:50 ratio, physical and mechanical properties of paper.

Name		CMC volume	Weight	Elongation	Thickness	Width	A0	τ	L
Waste paper of the MC-2 brand - 50%	Wood. Cell-50%	----	37,6 36,3 36,9	3,3 3,5 3,4	0,210 0,210 0,210	10 10 10	0,021 0,021 0,021	179 172,8 175,7	3,3 3,5 3,4
Waste paper of the MC-2 brand - 50%	Wood. Cell-50%	3ml	48 58 53	3,7 3,7 3,7	0,210 0,215 0,212	10 10 10	0,021 0,0215 0,0212	228,6 269,8 250	3,7 3,7 3,7
Waste paper of the MC-2 brand - 50%	Wood. Cell-50%	6 ml	43 28 35,5	3,2 2,8 3,0	0,200 0,212 0,206	10 10 10	0,02 0,0212 0,0206	215 132 172	3,2 2,8 3
Waste paper of the MC-2 brand - 50%	Wood. Cell-50%	9 ml	50,2 48,3 49,2	4,2 4,3 4,2	0,240 0,230 0,235	10 10 10	0,024 0,023 0,0235	209 210 209	4,2 4,3 4,2

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 4 , April 2021

Increasing the concentration of CMC in the composition of paper obtained from waste paper of the MS-2 brand and wood pulp in a ratio of 75:25 gives the best result by adding 0.75% CMC. At the same time, the tensile strength and rupture length are 3.7% and 224.4 kgf / cm2, respectively. It is known that the tensile strength and rupture length of the sample without the addition of CMC is 3.3% and 202 kgf / cm2.

Table 6
MS-2 brand waste paper and wood pulp
Effect of CMC concentration on paper obtained in ratios of 75:25 on physical and mechanical properties of paper.

Name		CMC volume	Weight	Elongation	Thickness	Width	A0	τ	L
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	----	46,2 43,2 44,7	3,7 3,0 3,3	0,220 0,223 0,221	10 10 10	0,022 0,0223 0,0221	210 193 202	3,7 3,0 3,3
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	3ml	44,2 52,4 48,3	3,1 3,5 3,3	0,200 0,215 0,207	10 10 10	0,02 0,0215 0,0207	221 243,7 233,3	3,1 3,5 3,3
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	6 ml	52 49 50,5	3,8 3,7 3,7	0,230 0,220 0,225	10 10 10	0,023 0,022 0,0225	226 222,7 224,4	3,8 3,7 3,7
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	9 ml	40 43 42	3,2 3,3 3,3	0,198 0,200 0,200	10 10 10	0,0198 0,02 0,02	202 215 210	3,2 3,3 3,3

In the process of obtaining paper from waste paper of the MS-2 brand and wood pulp in a ratio of 25:75, as a result, it increases the physical and mechanical properties of the paper, i.e. with the addition of 0.75% CMC, the tensile strength and rupture length are reached 3.6% and 266.7 kgf / cm2. In this regard, the tensile strength and tensile strength of the sample without the addition of CMC is 3.2% and 170.6 kgf / cm2.

Table 7

(MS-2 brand waste paper and wood pulp
Effect of CMC concentration on paper composition obtained in ratios of 25:75 on physical and mechanical properties of paper.)

Name		CMC volume	Weight	Elongation	Thickness	Width	A0	τ	L
Waste paper of the MC-2 brand - 25%	Wood. Cell-75%	----	27 46 36,5	2,9 3,6 3,2	0,210 0,218 0,214	10 10 10	0,021 0,0218 0,0214	128,6 211 170,6	2,9 3,6 3,2
Waste paper of the MC-2 brand - 25%	Wood. Cell-75%	3ml	43 44 44	3,3 3,3 3,3	0,220 0,230 0,225	10 10 10	0,022 0,023 0,0225	195,4 191,3 195,5	3,3 3,3 3,3

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 4 , April 2021

Waste paper of the MC-2 brand - 25%	Wood. Cell-75%	6 ml	56 56 56	3,7 3,4 3,6	0,210 0,210 0,210	10 10 10	0,021 0,021 0,021	266,7 266,7 266,7	3,7 3,4 3,6
Waste paper of the MC-2 brand - 25%	Wood. Cell-75%	9 ml	51 53 52	3,7 3,7 3,7	0,220 0,220 0,220	10 10 10	0,022 0,022 0,022	231,8 241 236	3,7 3,7 3,7

Further studies were carried out with low-viscosity brands of carboxymethyl cellulose. Cellulose from wood, waste paper of the MS-2 brand and compositions from waste paper and wood were selected as raw materials for the production of paper.

Obtaining paper from low-viscosity CMC gives different results than in the previous study.

The maximum result is obtained by adding 0.37% CMC to the composition of the paper. Based on this, the tensile strength is 3.7%, and the tensile strength is 233.3 kgf / cm2. Without the addition of CMC, the tensile strength and rupture length are 3.2% and 111.2 kgf / cm2.

Table 8
The effect of low-viscosity KMS on the physico-mechanical properties of paper obtained from wood pulp.

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Wood cell. 100%	34,2 33,4 33,8	3,4 3,01 3,2	0,300 0,308 0,304	10 10 10	0,030 0,030 0,030	114 108 111,2	3,4 3,01 3,2
Wood cell. + 0.37% CMC	63 63 63	3,7 3,8 3,7	0,27 0,28 0,27	10 10 10	0,027 0,028 0,027	233,3 225 233,3	3,7 3,8 3,7
Wood cell. + 0.75% CMC	48 43 45,5	3,4 3,2 3,55	0,28 0,28 0,28	10 10 10	0,028 0,028 0,028	177,8 153,6 162,5	3,9 3,2 3,55
Wood cell. + 1.1% CMC	62 58 60	3,5 3,4 3,4	0,30 0,30 0,30	10 10 10	0,030 0,030 0,030	206,7 193,3 200	3,5 3,4 3,4

Now, let us consider the effect of low-viscosity CMC on MS-2 waste paper. The best solution is to add 0.75% CMC. This means that the tensile strength and tensile strength is 3.3% and 350 kgf / cm2. At the same time, without adding CMC is 3.2% and 105.3 kgf / cm2, respectively.

Table 9
Tthe effect of low-viscosity KMS on the physical and mechanical performance of paper obtained from MS-2 brand waste paper

Name	Weight	Elongation	Thickness	Width	A0	τ	L
Waste paper brand MC-2 100%	29 27 28	2,97 3,4 3,2	0,240 0,293 0,266	10 10 10	0,024 0,029 0,021	120,8 92,1 105,3	2,97 3,4 3,2

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 4 , April 2021

Waste paper of the brand MC-2 + 0.37% CMC	54 58 56	2,7 3,0 2,85	0,20 0,20 0,20	10 10 10	0,02 0,02 0,02	270 290 280	2,7 3 2,85
Waste paper of the brand MC-2 + 0.75% CMC	63 63 63	3,3 3,3 3,3	0,18 0,18 0,18	10 10 10	0,018 0,018 0,018	350 350 350	3,3 3,3 3,3
Waste paper of the brand MC-2 + 1.1% CMC	49 58 53,9	3,1 3,4 3,25	0,20 0,18 0,19	10 10 10	0,020 0,018 0,019	245 322 284	3,1 3,4 3,25

High values were achieved by adding 0.75% CMC to a paper formulation made from a mixture of wood pulp and waste paper in a ratio of 25:75. It was found that the tensile strength is 3.8%, and the tensile strength is 221 kgf / cm2. Thus, without adding CMC, the composition of the paper is the tensile strength of 3.3%, and the tensile strength is 233.3 kgf / cm2.

Table 10

Influence of low-viscosity KMS on the physical and mechanical properties of paper obtained from MS-2 paper waste and wood cellulose in a ratio of 25:75

Name		CMC volume	Weight	Elongation	Thickness	Width	**A0**	τ	**L**
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	----	46,2 43,2 44,7	3,7 3,0 3,3	0,220 0,223 0,221	10 10 10	0,022 0,0223 0,0221	210 193 202	3,7 3,0 3,3
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	3ml	54 45 49,5	2,8 3,0 2,9	0,20 0,21 0,21	10 10 10	0,02 0,021 0,021	270 214 236	2,8 3,0 2,9
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	6 ml	48 45 46,5	3,5 4,1 3,8	0,21 0,20 0,21	10 10 10	0,021 0,020 0,021	229 225 221	3,5 4,1 3,8
Waste paper of the MC-2 brand - 75%	Wood. Cell-25%	9 ml	61 74 67,5	2,6 3,6 3,1	0,22 0,21 0,21	10 10 10	0,022 0,021 0,021	277 352 321	2,6 3,6 3,1

Thus, it was found that the addition of a certain amount of CMC in the composition of paper, depending on the feedstock, leads to an increase in the physical and mechanical properties of the final product.

REFERENCES

1. Thomas H. Carboxmethyl ether of cellulose and starch – a review, 2005. №3, –C.13-29.
2. Schweitzer D, Sorg C. Cellulose ethers for cement extrusion // – England:Woodhead, 1995, -pp. 47-61.
3. Salmi T., Valtakari D., Paatero E., Holmbom B., Sjoholm R. 1994. Kinetic study of the carboxymethylation of cellulose // Ind. Eng. Chem., -USA, 1994 Res. vol. 33– pp. 1454-1459.