International Journal of Research in Engineering and Innovation (IJREI)
journal home page: http://www.ijrei.com
ISSN (Online): 2456-6934

The analysis of the influence of carboxymethylcellulose on qualitative parameters of paper

S.A. Yuldoshov, I.T.Bokieva

[1]*Institute of Chemistry and Physics of Polymers of the Academy of Sciences of the Republic of Uzbekistan*
[2]*Tashkent Institute of Textile and Light Industry, Uzbekistan*

Abstract

In this article the composition of CMC has been studied in detail, which has a significant impact on the physical and mechanical properties of cellulose-based paper from wheat straw, wood, cotton and MS-2 waste paper. It also shows the optimal concentration of CMC in the production of paper with advanced physical and mechanical properties.
Keywords: First & second law efficiency, COP, EDR, ecofriendly refrigerants, nano materials

1. Introduction

Carboxymethyl cellulose (CMC), also called tylose, valocell, blanose, as well as ediface, polycel and carbocel in the market, 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].
World production of CMC is 47% of the total volume of cellulose ethers produced, and according to various sources, the global production of CMC today is from 180 to ~ 300 thousand tons / year. [3]. some scientific works are aimed at obtaining CMC technical grades 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].
The last decades of work have been carried out to improve existing technological processes, expand the CMC brand range and use more efficient devices for 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 also carried out in China [5]. Currently, Na-CMC is widely used in the oil and gas 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 that impart water resistance to the paper, as well as those that bind the fibers to each other in the paper sheet and thereby increase the tightness and mechanical strength of the paper, the former are called hydrophobic, and the latter are called adhesive sizing substances [7]. To extend the efficiency of sizing, as well as to increase the strength properties of paper in the process, adhesive sizing materials are used, which include: cellulose derivatives carboxymethyl cellulose.
The process of sizing paper in bulk starts from the moment the glue is introduced into the water-fiber suspension and ends in the drying section of the paper machine. Therefore, starting from this moment and ending with the receipt of finished products, this process is subject to the active influence of many technological factors. At the same time, sizing materials and coagulants introduced into the colloidal chemical system have a great influence on almost all the properties of this system, i.e. they themselves are a disturbing factor [7].
Adding CMC to the 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 paper [8].
We have studied the effect of CMC concentration on the physical and mechanical properties of paper. Cotton, straw, wood, waste paper (grade MS-2) and their compositions with a degree of grinding 35^0 ShR were used as feedstock for paper casting.

Corresponding author: S .A. Yuldoshov
Email Address: yuldoshev@gmail.com
https://doi.org/10.36037/IJREI.2020.4305

2. Results and Discussion

By increasing the concentration of CMC in the composition of paper obtained from wheat straw, physical and mechanical parameters pass through a maximum. The maximum strength of the paper from the straw mass is achieved by adding 0.75% CMC. At the same time, the tensile strength and fracture lengths of the sample are 3% and 72 kgf /sm^2, respectively. In this case, the tensile strength and fracture lengths of the sample without the addition of CMC are 2.24% and 69 kgf /sm^2, in turn aas shown in table 1.

Table 1. Tensile strength and fracture lengths

Name	Weight	Removal	Thickness	Width	A_0	τττ	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. + 3 ml 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. + 6 ml 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. + 9 ml 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, with the addition of 0.75% CMC to wood pulp paper, its physical and mechanical properties, i.e. tensile strength and fracture lengths of the sample reaches up to 3.2% and 167.8 kgf /sm^2. At the same time, the tensile strength and fracture lengths of the sample without the addition of CMC are 3.2% and 111.2 kgf /sm^2, respectively as shown in table 2.

Table 2. Tensile strength and fracture lengths

Name	Weight	Removal	Thickness	Width	A_0	τ	L
Woody Cell. 100%	34.2	3.4	0.300	10	0.030	114	3.4
	33.4	3.01	0.308	10	0.030	108	3.01
	33.8	3.2	0.304	10	0.030	111.2	3.2
Woody Cell. + 3 ml CMC	36.2	2.96	0.340	10	0.034	106.4	2.96
	36.3	2.98	0.350	10	0.035	103.7	2.98
	36.2	2.97	0.345	10	0.034	104.9	2.97
Woody Cell. + 6 ml CMC	54	3.3	0.298	10	0.029	181.2	3.3
	48	3.1	0.310	10	0.031	154.8	3.1
	51	3.2	0.304	10	0.030	167.8	3.2
Woody Cell. + 9 ml CMC	55	3.6	0.290	10	0.029	189.6	3.6
	56	2.7	0.250	10	0.025	224	2.7
	55	3.1	0.270	10	0.027	203.7	3.1

Table 3: Analyze strength and fracture lengths

Name	Weight	Removal	Thickness	Width	A_0	τ	L
Cotton Cell. 100%	84.3	4.46	0.280	10	0.0280	301	4.46
	68.7	2.6	0.290	10	0.0290	236	2.6
	76.5	3.53	0.285	10	0.0285	268.5	3.53
Cotton Cell. And 3ml CMC	31	2.89	0.200	10	0.02	155	2.89
	31.6	2.89	0.205	10	0.0205	154	2.89
	31.3	2.89	0.205	10	0.02	154.5	2.89
Cotton plant. and 6ml CMC	43	7.95	0.190	10	0.0190	226	7.95
	38	6.95	0.200	10	0.020	190	6.95
	40.5	7.45	0.195	10	0.0195	207	7.45
Cotton Cell. and 9ml CMC	94.3	6.9	0.240	10	0.024	392	6.9
	72	7.1	0.260	10	0.026	277	7.1
	83.1	7	0.250	10	0.025	332	7

In table 3, the increase in CMC content in cotton pulp paper to 1.1% significantly rises the strength properties and elongation of 7% and a gap length of 332 kgf /sm^2. Moreover, the tensile strength and fracture lengths of the sample without the addition of CMC are 3.53% and 268.5 kgf /sm^2, respectively.

The optimal values of physical and mechanical properties of paper obtained from waste paper grade MS-2 is achieved by adding 1.1% CMC. At the same time, its strength indicators increase: the effect on the elongation is 3.3% and the gap length is 142.9 kgf /sm^2. At the same time, the tensile strength and fracture lengths of the sample without the addition of CMC are 3.2% and 105,3 kgf /sm^2,in turn.

Table 4: Physical and mechanical properties

Name	Weight	Removal	Thickness	Width	A_0	τ	L
Waste paper of the brand MS-2 100%	29	2.97	0.240	10	0.024	120.8	2.97
	27	3.4	0.293	10	0.029	92.1	3.4
	28	3.2	0.266	10	0.021	105.3	3.2
Waste paper of the brand MS-2 + 3 ml CMC	28	3.2	0.220	10	0.022	127.3	3.2
	35	3.4	0.250	10	0.025	140	3.4
	31.5	3.3	0.235	10	0.023	134	3.3
Waste paper of the brand MS-2 + 6 ml CMC	27	2.7	0.220	10	0.022	122.7	2.7
	29	2.8	0.220	10	0.022	131.8	2.8
	28	2.7	0.220	10	0.022	127.3	2.7
Waste paper of the brand MS-2 + 9 ml CMC	37	3.5	0.230	10	0.023	160.8	3.5
	32	3.9	0.260	10	0.026	123.1	3.9
	35	3.7	0.245	10	0.024	142.9	3.7

To further study the quality indicators, paper was obtained from composite raw materials with different ratios, such as a composition from MS-2 waste paper and wood pulp with ratios of 50: 50, 75: 25, 25: 75. The addition of 0.37% CMC obtained from equal proportions of MS-2 waste paper and wood pulp improves its quality indicators, i.e. tensile strength is 3.7% and a gap length is 250 kgf /sm^2. At the same time, without adding CMC to the paper, the tensile strength is 3.4%, and the gap length is 175.7 kgf /sm^2.

Table 5: Features of the waste paper of the brand

Name		Volume CMC	Weight	Removal	Thickness	Width	A_0	τ	L
Waste paper of the brand MS-2- 50%	Wood. Cell 50%	----	37.6	3.3	0.210	10	0.021	179	3.3
			36.3	3.5	0.210	10	0.021	172.8	3.5
			36.9	3.4	0.210	10	0.021	175.7	3.4
Waste paper of the brand MS-2 -50%	Wood Cell 50%.	3 ml	48	3.7	0.210	10	0.021	228.6	3.7
			58	3.7	0.215	10	0.0215	269.8	3.7
			53	3.7	0.212	10	0.0212	250	3.7
Waste paper of the brand MS-2 -50%	Wood Cell 50%	6 ml	43	3.2	0.200	10	0.02	215	3.2
			28	2.8	0.212	10	0.0212	132	2.8
			35.5	3.0	0.206	10	0.0206	172	3
Waste paper of the brand MS-2 -50%	Wood Cell 50%	9 ml	50.2	4.2	0.240	10	0.024	209	4.2
			48.3	4.3	0.230	10	0.023	210	4.3
			49.2	4.2	0.235	10	0.0235	209	4.2

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

Table 6: Aspects of paper waste and brand

Name		Volume CMC	Weight	Removal	Thickness	Width	A_0	τ	L
Waste paper of the brand MS-2- 75%	Wood Cell 25%	----	46.2	3.7	0.220	10	0.022	210	3.7
			43.2	3.0	0.223	10	0.0223	193	3.0
			44.7	3.3	0.221	10	0.0221	202	3.3
Waste paper of the brand MS-2 -75%	Wood Cell 25%	3 ml	44.2	3.1	0.200	10	0.02	221	3.1
			52.4	3.5	0.215	10	0.0215	243.7	3.5
			48.3	3.3	0.207	10	0.0207	233.3	3.3
Waste paper of the brand MS-2 -75%	Wood Cell 25%.	6 ml	52	3.8	0.230	10	0.023	226	3.8
			49	3.7	0.220	10	0.022	222.7	3.7
			50.5	3.7	0.225	10	0.0225	224.4	3.7
Waste paper of the brand MS-2 -75%	Wood Cell 25%.	9ml	40	3.2	0.198	10	0.0198	202	3.2
			43	3.3	0.200	10	0.02	215	3.3
			42	3.3	0.200	10	0.02	210	3.3

In the process of obtaining paper from MS-2 waste paper and wood pulp in a ratio of 25:75, it ultimately increases the physical and mechanical properties of paper, i.e. with the addition of 0.75% CMC, the tensile strength and tear length are reached 3.6%

and 266.7 kgf /sm^2. In this regard, the tensile strength and the fracture length of the sample without the addition of CMC is 3.2% and 170.6 kgf /sm^2.

Table 7: Characteristics of physical and mechanical properties of paper

Name		Volume CMC	Weight	Removal	Thickness	Width	A_0	τ	L
Waste paper of the brand MS-2 - 25%	Wood Cell 75%	----	27	2.9	0.210	10	0.021	128.6	2.9
			46	3.6	0.218	10	0.0218	211	3.6
			36.5	3.2	0.214	10	0.0214	170.6	3.2
Waste paper of the brand MS-2 - 25%	Wood Cell 75%	3 ml	43	3.3	0.220	10	0.022	195.4	3.3
			44	3.3	0.230	10	0.023	191.3	3.3
			44	3.3	0.225	10	0.0225	195.5	3.3
Waste paper of the brand MS-2 - 25%	Wood Cell 75%	6 ml	56	3.7	0.210	10	0.021	266.7	3.7
			56	3.4	0.210	10	0.021	266.7	3.4
			56	3.6	0.210	10	0.021	266.7	3.6
Waste paper of the brand MS-2 - 25%	Wood Cell 75%	9ml	51	3.7	0.220	10	0.022	231.8	3.7
			53	3.7	0.220	10	0.022	241	3.7
			52	3.7	0.220	10	0.022	236	3.7

Further studies were conducted with low viscosity grades of carboxymethyl cellulose. Pulp from wood, MS-2 waste paper and compositions from waste paper and wood were selected as raw materials for paper production. Getting paper from low-viscosity CMC gives various results than in the previous study.

The maximum result is the addition of 0.37% CMC paper composition. Based on this, the tensile strength is 3.7%, and the fracture length is 233.3 kgf /sm^2. Without the addition of CMC, the tensile strength and fracture length are 3.2% and 111.2 kgf /sm^2.

Table 8: Analyses of tensile strength and fracture

Name	Weight	Removal	Thickness	Width	A_0	τ	L
Woody Cell. 100%	34.2	3.4	0.300	10	0.030	114	3.4
	33.4	3.01	0.308	10	0.030	108	3.01
	33.8	3.2	0.304	10	0.030	111.2	3.2
Woody Cell. + 3 ml CMC	63	3.7	0.27	10	0.027	233.3	3.7
	63	3.8	0.28	10	0.028	225	3.8
	63	3.7	0.27	10	0.027	233.3	3.7
Woody Cell. + 6 ml CMC	48	3.4	0.28	10	0.028	177.8	3.9
	43	3.2	0.28	10	0.028	153.6	3.2
	45.5	3.55	0.28	10	0.028	162.5	3.55
Woody Cell. + 9 ml CMC	62	3.5	0.30	10	0.030	206.7	3.5
	58	3.4	0.30	10	0.030	193.3	3.4
	60	3.4	0.30	10	0.030	200	3.4

Now, consider the effect of low viscosity CMC on waste paper of the brand MS-2. The best solution is to add 0.75% CMC. This means that the tensile strength and tear length are 3.3% and 350 kgf /sm^2. Moreover, without the addition of CMC it is 3.2% and 105.3 kgf /sm^2, respectively.

Table 9: Analyses of the effect of low viscosity CMC on waste

Name	Weight	Removal	Thickness	Width	A_0	τ	L
Waste paper of the brand MS-2 100%	29	2.97	0.240	10	0.024	120.8	2.97
	27	3.4	0.293	10	0.029	92.1	3.4
	28	3.2	0.266	10	0.021	105.3	3.2
Waste paper of the brand MS-2 + 3 ml CMC	54	2.7	0.20	10	0.02	270	2.7
	58	3.0	0.20	10	0.02	290	3
	56	2.85	0.20	10	0.02	280	2.85
Waste paper of the brand MS-2 + 6 ml CMC	63	3.3	0.18	10	0.018	350	3.3
	63	3.3	0.18	10	0.018	350	3.3
	63	3.3	0.18	10	0.018	350	3.3
Waste paper of the brand MS-2 + 9 ml CMC	49	3.1	0.20	10	0.020	245	3.1
	58	3.4	0.18	10	0.018	322	3.4
	53.9	3.25	0.19	10	0.019	284	3.25

High values were achieved by adding 0.75% CMC to the paper composition made from a mixture of wood pulp and waste paper in a ratio of 25:75. It was established that the tensile strength is 3.8%, and the tensile strength is 221 kgf /sm^2. Thus, without the addition of CMC, the paper composition has a tensile strength of 3.3%, and a tensile length strength of 233.3 kgf /sm^2.

Table 10: Research on paper composition has a tensile strength

Name		Weight	Removal	Thickness	Width	A_0	τ	L	Name
Waste paper of the brand MS-2-75%	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 brand MS-2-75%	Wood Cell 25%	3 ml	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 brand MS-2-75%	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 brand MS-2-75%	Wood Cell 25%	9ml	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

3. Conclusions

The way of the research has been pinpointed on different points to make better analyses on various contents. In order to make better development, analyses of the research has been concluded with both outcomes and shortcomings as the whole. Thus, it was found that the addition of a certain amount of CMC in the paper, depending on the feedstock, leads to an increase in the physic-mechanical properties of the final product.

References

[1] Cooper V.A., Kazantsev V.V. The state of production of cellulose ethers // Cellulose ethers and starch: synthesis, properties, application. Materials of the Xth anniversary of All-Russia. scientific and technical conf. with int. participation. Ed. V.A. Cooper. Suzdal, 2003, 9-26.

[2] Thomas H. Carboxmethyl ether of cellulose and starch - a review, J. Chemistry of Plant Raw Materials, Barnaul, 2005. No. 3, 13-29.

[3] Schweitzer D, Sorg C. Cellulose ethers for cement extrusion, England: Woodhead, 1995, 47-61.

[4] Tikhonovetskaya A.D., Atakhanov A.A., Ruziev F., Juraev A., Nabiev D.S., Rashidova S.Sh. Development of optimal conditions for the production of carboxymethylated cellulose ethers based on cotton cellulose, Conference: Actual problems of chemistry, physics and technology of polymers, Tashkent: IHPP AN RUz, November 9-10, 2009, 99-101.

[5] Kryazhev V.N., Shirokov V.A. The state of production of cellulose ethers, Chemistry of plant raw materials, -Barnaul, 2005- No.3, 7-12.

[6] 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, 1454-1459.

[7] Markin V.I. Carboxymethylation of plant materials, Theory and Practice - Barnaul, 2010, 167-175.

[8] CIS carboxymethyl cellulose market overview. InfoMine - Moscow. 2011, 135 p. 4. Markin V.I. Carboxymethylation of plant materials, Theory and Practice - Barnaul, 2010, 167.

Cite this article as: S.A. Yuldoshov, I.T.Bokieva, The analysis of the influence of carboxymethylcellulose on qualitative parameters of paper, International Journal of Research in Engineering and Innovation Vol-4, Issue-3 (2020), 149-153.*https://doi.org/10.36037/IJREI.2020.4305*.