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A STUDY OF THE PHYSICAL STABILITY OF SOME ION-EXCHANGE RESINS

by

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SUMMARY

In a comparative study the relative physical stability of 14 ion-exchange resins was evaluated for potential use in resin-in-pulp processes. When tumbled over a period of time with a 50% pulp of quartz and water a wide range in the physical stability of resins was noted.

The volume loss of the anion exchanger Dowex 21K was only 1.5% after 6 days of tumbling. The cation exchanger Dowex 50W x 8 lost 7% of its volume in 4 days. By comparison several resins had high, initial, volume losses of from 11 to 20% in the first day. These losses escalated to 28 and 46% after 11 to 20 days.

When a resin-in-pulp process is being considered this study shows the importance of selecting a resin for low attrition losses, as well as for high metal capacity and suitable operating characteristics.

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INTRODUCTION

The purpose of this program was to study the relative physical stability of commercially available ion exchange resins against mechanical attrition normally experienced in resin-in-pulp (R.I.P.) processes. High physical stability against resin breakdown, resulting in minimum resin losses, is one of the desirable properties for a solid exchanger in a R.I.P. process[1]. Resistance to attrition is of particular importance when recovering high-priced metals. Resin losses from 12%[5] to 38%[3] per year have been reported in resin-in-pulp plant processes. T.V. Arden[2] has written that after an initial fracture of the fragile resin beads the resin losses decreased to zero.

The relative physical stability of 14 resins was studied by tumbling the plus 20-mesh fraction of each resin with a 50% solids slurry of quartz and water for 24-hour periods. After each tumbling period the quartz was separated from the resin by wet screening. The daily volume decrease of plus 20-mesh resin was measured.

TEST PROCEDURE

Three resin manufacturers supplied the 14 samples of resin listed in Table 1 for physical testing. Before testing these resins were soaked in water overnight after which the plus 20-mesh fraction was separated from the bulk sample by wet screening on Tyler screens. The washed quartz from International Minerals Buckingham Quebec was ground to 98.8% minus 48 plus 200 mesh.

For each test 100 ml of plus 20-mesh fraction of resin was tapped and settled to a constant volume in a cylindrical graduate. The resin was then transferred to a 32-oz wide-mouth bottle containing 500 g washed quartz and 500 ml distilled water. The sealed bottle and contents were tumble-agitated on a Fisher-Kendall Mixer at 58 rpm. After 24 hours the bottle contents were transferred to a 20-mesh Tyler screen. The quartz and minus 20-mesh resin were washed through the screen. The plus 20-mesh resin was transferred to a cylindrical graduate, tapped to a constant volume, and any volume loss was recorded as a percentage of the initial resin volume.

TABLE 1

Resin Manufacturers and Resins Submitted for Testing

Manufacturer	Type of Resin Supplied
Dow Chemical of Canada Ltd.	Dowex 11: Strongly basic anion exchanger, commercial Dowex 21K: Strongly basic anion exchanger, commercial Dowex 50WX8: Strongly acidic cation exchanger, commercial
Rohm & Haas Company of Canada Ltd.	Amberlite IRA-425: Strongly basic anion exchanger, commercial Amberlite IRA-900C: Strongly basic macrorecticular* anion exchanger, commercial Amberlite IR-120L: Strongly acidic cation exchanger, commercial Amberlite 200C: Strongly acidic macroreticular* cation exchanger, commercial.
Diamond Shamrock Chemical Co., Redwood City, California	Duolite A-57: Weakly basic anion exchanger, commercial Duolite A-101-D: Strongly basic anion exchanger, commercial Duolite ES-109: Strongly basic anion exchanger, semi-commercial Duolite ES-111: Strongly basic anion exchanger, semi-commercial Duolite C-20: Strongly acidic cation exchanger, commercial Duolite ES-26: Strongly acidic cation exchanger, semi-commercial macroporous* Duolite ES-28: Strongly acidic cation exchanger, semi-commercial

* Macroreticular or macroporous resins are resins of high porosity and surface area.

The plus 20-mesh resin was then returned to a 32-oz bottle, containing a fresh charge of quartz and water. This procedure was repeated for a total of 20 days, or until the daily loss was zero whichever came first. The percentage of the coarser plus 14-mesh resin beads, in the plus 20-mesh sample, was determined before and after the total attrition period.

RESULTS

The results of the attrition tests are compiled in Table 2. To analyse the attrition results in Table 2 the cumulative percent volume loss of resin was plotted against time. The curves (Figures 1 and 2) show a characteristic resin loss of 0.5 to 20% in the first two days. After this initial loss the daily losses decreased, sometimes rapidly. The most stable resin studied was the anion exchanger, Dowex 21K, which contained 20% by volume of plus 14-mesh beads. Dowex 21K had zero resin loss after the first day and a final loss of 1.5% after six days. Dowex 50WX8, the most stable cation exchanger, with 40% by volume of plus 14-mesh beads, had a maximum volume loss of 7% after eight days. The initial volume loss was 4.5% after two days. The anion exchanger Amberlite IRA-425 had an initial loss of 2% and a maximum loss of 7% after eight days of attrition.

Amberlite 200C and Duolite A-57 lost 5% and 6% respectively, in the first day of tumbling. After thirteen days the maximum volume loss was 19%. The least physically stable resin, Duolite ES-111, lost 20% of the initial volume in the first day. This loss continued at the rate of 1 to 2% per day. The cumulative resin loss was 46% after twenty days.

The breakdown of the coarse plus 14-mesh resin beads varied from 1 to 5%. Amberlite 200C and Amberlite IR 120L with an initial plus 14-mesh fraction of about 10%, had a breakdown of 1%. Amberlite IRA-425, with an initial coarse fraction of 89%, had a breakdown of 5%.

DISCUSSION

The attrition results tend to agree with T.V. Arden's[2] statement that initial resin losses decrease to a minimum over a period of time. With most of the resins tested, there was a relatively high initial resin loss which, with one exception, decreased to zero in 4 to over 20 days. This pattern was attributed to the breakdown of the more fragile beads of resin.

TABLE 2

Results of Relative Attrition Testing of Resins

Resin	Type of Resin		Plus 14-Mesh Resin %		Daily Cumulative Resin Loss %																			
					Days																			
	Anion	Cation	Initial	Final	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Dowex 11	x		27	25	1	6	8	11	13	13.5	13.5	15	16	16	16									
Dowex 21K	x		23	21	0	0.5	1	1	1	1.5	1.5	1.5												
Dowex 50WX8		x	44	41	1	4.5	6.0	7	7	7														
Amberlite IRA-425	x		89	84	2	2.5	4	5	6	6	6.5	7	7	7										
Amberlite IRA-900C	x		19	16	7	9.5	11	13.0	13.0	15	15	16	17	17.5	17.5	17.5								
Amberlite IR-120L		x	9	8	14	15.5	16	19	20	20	20													
Amberlite 200C		x	12	11	5	8	11	12	13	14.5	15	15.5	16.5	17	17.5	18	19	19	19					
Duolite A-57	x		8	4	6	8.5	9	12.5	12.5	14	15	15.5	16	17	18	18.5	19	19	19					
Duolite A-101-D	x		3	0	13	16	18	19.5	20	21	22	22	22											
Duolite ES-109	x		2	0	15	20	23	25	25.5	26	26	27	27	27										
Duolite ES-111	x		0	0	20	24.5	27	29	29.5	32	33	33	35	36	36.5	37.5	39	39.5	40.5	42	43.5	44.5	45	46
Duolite C-20		x	4	1	4	7	9	11	13	13	13													
Duolite ES-26		x	12	10	5	7.5	9.5	11	11.5	12	12.5	12.5	12.5											
Duolite ES-28		x	2	0	11	16	20	22	24	25	25.5	26	27	27	28	28	28							

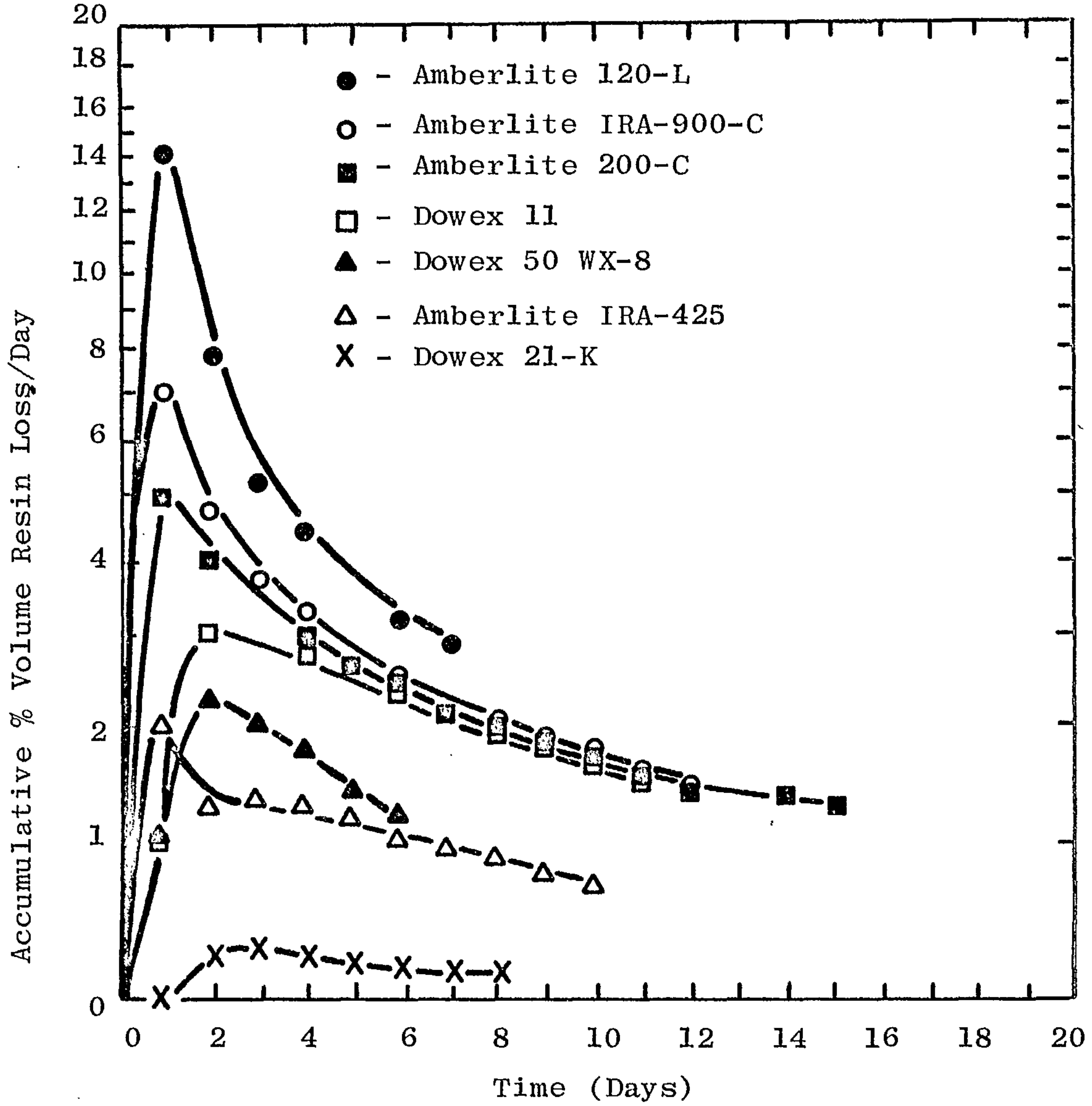

Figure 1. Curves Showing
1. Initial resin losses
2. The rate of decrease of resin losses to a minimum, for Amberlite and Dowex Resins

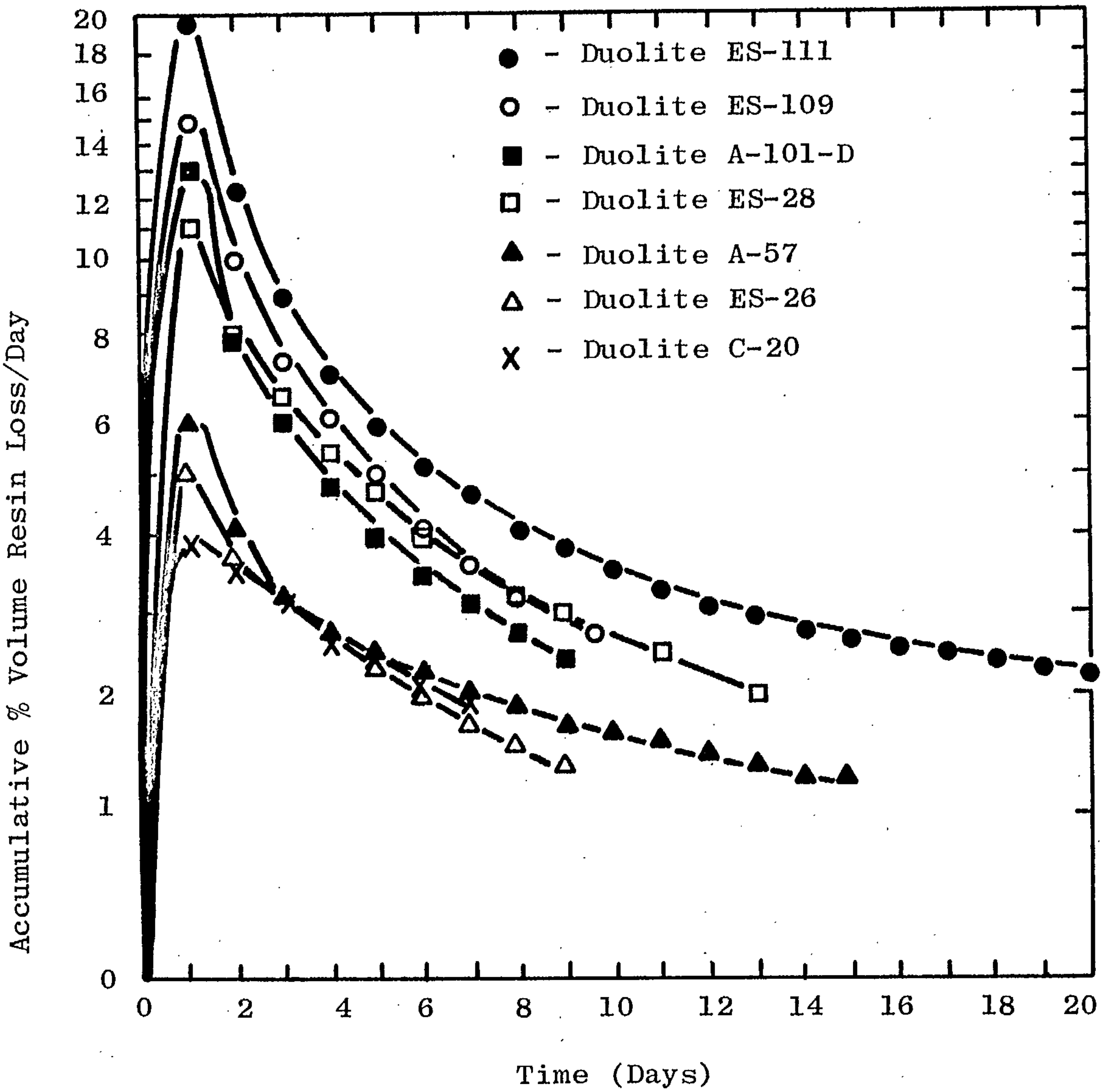

Figure 2. Curves Showing
1. Initial resin losses
2. The rate of decrease of resin losses to a minimum, for Duolite resins

For the resins tested there does not appear to be any indication that fine resin beads are any more resistant to abrasion than coarse beads.

The procedure used for the attrition testing was a modification of that used by American investigators[3] on experimental resins. They tested 100 ml resin in a quartz pulp of 33% solids at a resin/aqueous volume ratio of 2/1. Our procedure with a quartz pulp of 50% solids and a resin/aqueous volume ratio of 1/5 approximated operational conditions for a R.I.P. process.

In practice, it is unlikely that the composition and characteristics of the slurry would result in more severe resin attrition than that obtained under the conditions used in this work. During resin transfer in commercial operations mechanical attrition is minimal for low flow rates of resin slurries of about 150 gpm under 15 psi of pressure[4]. On the other hand, in practice resin breakdown occurs from the presence of strong oxidants and from osmotic shock due to volume changes during sorption and desorption, and the effects of these variables was not investigated in this study.

The choice of one of the more physically stable resins would be of particular economic significance in the R.I.P. processing of a costly metal such as gold. In such an operation resin losses would have to be at a minimum because of the high value of any metal lost on abraded resin. The anion exchanger Dowex 21K, because of the high physical stability indicated in this work, should be considered for gold recovery from cyanide pulps.

CONCLUSION

This comparative attrition study of currently marketed resins shows that there is a wide variation in the physical stability of commercially available ion-exchange resins. Therefore when selecting a resin for a resin-in-pulp process the physical stability of the resin to mechanical attrition is as important as the resin's chemical characteristics.

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