Diatomaceous Earth Filtration

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For many years, sand filtration was the basic tool of water clarification in the oil industry. However, it became apparent that where zones of low permeability were involved, greater clarity of injection water was necessary; and, because of its high clarification capacity while achieving an economical flow rate, diatomite filtration immediately proved its worth as a solution to this problem.

Because of the design of sand filters as compared to that of diatomite filters, the popular concept of sand filters being lower in cost than are diatomite filters prevailed until the past few years. The processing of new grades of diatomite, of grades that give higher filtration rates than ever before, coupled with new mechanical designs of filters has placed diatomite filtration along side of sand filters, when costs are concerned and far ahead when performance are considered.

The clarifying capacity of various grades of diatomite vary from removal down to 1/10 micron to removal down to 5 microns. This coarset grade which removes down to five micron particle size material has 200 per cent greater clarifying capacity than does sand and equal filtration rate. However, if clarity is the prime factor, the medium grade, which removes down to 1 micron particle size, is most widely used.

To discuss the economics of filtration, a little background will be necessary. Practically all the diatomite filters used in the oil industry are of the pressure type, and their designs varies from tubular elements to the rotating leaf type, which is most widely used. These leaves or elements are usually a metal backing with a metal cloth covering. However, where corrosion is involved, synthetic cloths replace the metal cloth.

Because of the wide openings of the cloths, generally 60 by 60 mesh, it is necessary to use a precoat of an asbestos-cellulose mixture to trap out the diatomite used for precoat. This precoating is done by filling the filter shell with water, adding the asbestos-cellulose mixture in the slurry tank; and circulating it through the filter until the mixture is deposited on the cloths. Once this process is completed, an after-precoat of diatomite is then deposited on top of the asbestos-cellulose mixture in the same manner. But the precoat is a very good filter media and would soon become plugged with the solids being removed unless a slurry of diatomite is continuously fed into the in-put stream of water. And, by the use of filter aid or slurry, filtration cycles may be extended as much as 100 times.

An important part in the economics of diatomite filtration, filtration rate is the flow of a definite volume of liquid through a definite filtering area per unit of time (e.g., gal per sq ft per minute.) For instance different rates can be applied to the same filter area; and, in each case, the same water and solids, the same type diatomite, etc., are used. A rate of six gal per sq ft per minute will give a relative cycle of four hr, four gal per sq ft per minute; eight hr, three gal per sq ft per minute; thirteen hr, two gal per sq ft per minute; twenty-eight hr, one gal per sq ft per minute; ninety-two hours. If one uses this computation as a basis and if it is assumed that one is filtering a volume of 10,000 BPD, the economics involved on an annual basis are shown in Table 1:

TABLE 1

	1 gpm	2 gpm	3 gpm	4 gpm
Cycles	95	313	540	1100
Asbestos Precoat (#) (Note 1)	830	1360	1580	2190
Asbestos Precoat ($) (Note 2)	352.75	578.00	671.50	930.75
Diatomite Precoat (#) (Note 3)	2760	4540	5200	8030
Diatomite Precoat ($) (Note 4)	111.00	181.00	209.00	321.00
Flow (Gal/Min)	291	291	291	291
Filtering Area (ft^2)	291	145	97	73
Total Filter Cost ($) (Note 5)	11650.00	5800.00	3880.00	2910.00
Annual Filter Cost ($) (Note 6)	1165.00	580.00	388.00	291.00
Water for Backwash (Bbl) (Note 7)	2375	7825	13500	27500
Water for Backwash ($) (Note 8)	2.375	7.825	13.500	27.500
Labor to Backwash (Note 9)	47.5	156.5	270	550
Labor to Backwash ($) (Notes 10 & 13)	142.00	469.50	810.00	1650.00
Filter Down Time	47.5	156.5	270	550
Slurry (#) (Note 11)	25550	25550	25550	25550
Slurry ($) (Note 4)	1022.00	1022.00	1022.00	1022.00
Utilities ($) (Note 12)	1095.00	1095.00	1095.00	1095.00
Maintenance ($)	150.00	150.00	150.00	150.00
Total/Year ($)	4040.12	4083.32	4359.00	5487.25
Cost/Bbl ($)	.001106	.001118	.001194	.001503

TABLE I

Appendix 1 Notes

1. **3#/100 sq ft filtering area**
2. **$0.425/# carload delivered price**
3. **10#/100 sq ft filtering area**
4. **$0.04/# carload delivered price**
5. **Package filter system based on $40.00/sq ft filtering area**
6. **Based on assumption that the filter will be used for ten years**
7. **Based on 25 Bbls/cycle or backwash**
8. **Based on $0.001/Bbl**
9. **30 min/backwash or cycle**
10. **Based on $3.00/hr**
11. **Assume 20 ppm and 1 ppm diatomite to 1 ppm solids**
12. **Based on an average cost of $3.00/day**
13. **In many cases, personnel involved witp their normal activities in the filter station area operate the filter at a much lower cost than shown. The costs shown would be where a person devotes the entire alloted time to the backwash cycle.**

Where consideration is between diatomite filtration and no filtration, the figures in Table I are merely the operating costs of the filter. Consideration should be given to the other cost reducing factors:

1. Lower pumping costs, brought about by the high clarity of diatomite filtration and in turn a lower solid load in the zone.
2. Decrease or elimination of treating costs, specific inference is given to bacteria or algae, etc.

Where consideration is between diatomite filtration and sand filtration, interest should be given to the following cost reducing factors:

1. Greater water quality (resulting in lower pumping cost as previously outlined)
2. Backwash requirements reduced from 1000 Bbl. to 25 Bbl/cycle.
3. Raw water collection tanks unnecessary.
4. If oil is in the water, it will plug on the face of the filter cake, enabling the oil to be removed with the cake; this compares to the same situation of oil on the sand bed which if the oil cannot be backwashed, nor acid flushed, the bed must be changed.
5. Reduction of real estate requirements by 65 per cent (including backwash pit)
6. Reduction of hold time in clear water collection tank by 90 per cent
7. Smaller pumps for backwash, etc.

Many variables are involved in the proper operation of diatomite filtration; turbidity is the first consideration. If solids are involved, a ratio of one part diatomite to one part solid may be used, while oil in water must be handled at a ratio of two parts diatomite to one part oil. However, if both oil and solid are involved, each should be calculated separately and totaled.

The second consideration is turbidity particle size. If the particles are of such a nature that the majority may be removed by one of the coarser grades of diatomite, then faster flow per unit of area may be obtained. However, if the turbidity particle size requires that one of the finer grades be used, flow rates must be sacrificed for desired clarity.

When comparing a manually operated diatomite filter vs a manually operated sand filter and a completely automatic diatomite filter vs a completely automatic sand filter, cost per barrel is at least equal and in many cases lower when diatomite is utilized. This cost advantage, added to the higher quality water available by diatomite filtration, shows that diatomite no longer has to be a second consideration and that it is now a prime clarifier of water in the oil industry.