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High Volume, High BOD Mastes: the Magnetic Separations

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Introductions

implementation of BPA ?zero discharge? regulations may present

problens for industries discharging unusually high volumes of aqueous wastes

containing high BOD lévels. Proce:

125 from which aqueous wastes contain &

1158 load which does not settle readily in lagoons are also question marks

with respect to new regulations. on-point source pollution such as septic

tank drainage field failure? during heavy rains has just begun to receive
some attention by the authorities and the potential of non-point sources for
fresh water pollution is probably quite a bit higher than that of any in
dustrial discharge.

?the options usually considered viable for waste water treatment
?are given in Table 1, along with some renarks which characterize sone of the
weaknesses in each. Tt should be clearly noted, that in spite of dravbacks
ited, each method is capable of coping with one or more than one type of
waste in what {8 considered to be a cost effective (or at least: cost compet~
itive) manner.

Vety recently, @ new and general adaptation of an older treatment
method used for very specific wastes has emerged as a candidate for problematic
effluents. Reference is made in this paper to the technique of seeded high
gradient magnetic separation or magnetic £iltration. There are nov some
reasons? to believe that it ie an important now am in the arsenal of method=
ology that the waste water treatment engineer can deploy.

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TABLE 1

Treatment Technologies as Currently Practiced

Treatment Technology Coments

Anaerobic Contact, Re-aeration of discharge required;

large investment for high 80D re-

moval.

Aerobic Contact, Odor problem. May not treat

chlorinated pesticide residues.

Aerobic Lagooning Large land areas may be required.

urtace aerators (ean) Darge operas

tion costs. ?

Anaerobic/Aerobic Tank May involve large land areas, high

capital expenditures and ?require

highly trained operators.

Direct Land Application Monitoring of disposal area

necessary. Not feasible if Tong

sewerage Tines are needed. Large,

managed crop land area required.

Evaporation Sludge transport and disposal

management more urgent. Can be

energy intensive. Can necessitate

Jong hold up times.

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Description of the Technique

New ideas, materials and concepts have permitted the development

of high gradient magnetic fields which are confined to a conduit through

which a fairly rapialy moving stream of suspended magnetic particles passes.

she

felt by magnetic materials in the stream. ?they are capable of efficient sparation or filtration of even weakly magnetic suspended solids or pre~

?nigh gradient magnetic separators are designed to maximize the force

cépitates for which conventional magnetic separation techniques are inef- fective. this capability is the result of the development of a filamentary ferromagnetic matrix and a large volune, high-field magnet. The combination of an efficient magnet and high gradient matrix permits the economical genere~ tion of strong magnetic forces over a large surface area in the magnetic filter bed (Pigure 1). Filtration may be carried out economically, and at process rates of up to several hundred gallons per minute per square foot

of fluid stream cross section (gem/et?).

Large scale industrial applications of this technology already

exist for vaste water treatment in steel mills and stean condensate treat-

ment in paper mills. Monerous large installations also exist in the clay

Industry for the separation of fine impurities from clay slurries.

For normally nonmagnetic colloidal material in polluted water, the

?addition of magnetic iron oxide powder (magnetite) along with a coagulant can

form a combined particle sufficiently magnetic to be renoved by high gradient

?The machines provide a rapid filtration of many pollutants:

from vater with a small expenditure of energy. They are more efficient than

sedinentation because the magnetic forces on fine particles are many tines

greater than gravitational forces.

magnetic filter:

Municipal and industrial waste water treatment by high gradient

magnetic filtration with iron powder seeding is under active development in

several countries. Applications include treating combined storm and sever

overflow, raw sewage and waste waters from paper, petrochemical and other in-

Austries. A summary of applications, their respective states of development

and country of development is given in Table 2.

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FIGURE I

High Gradient Magnetic Separation Filter

Showing Section of Matrix Wire

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mae 2

Gradient ¥¢ aration and Filtration Armlications

State of Full scale

velopment] Application | Full scale| Development| Research} Country

Application Operating | Plannod

Boiler Water USA, Japan,

?reatnent x x x x | ussk

Chay x x x x | Usa, UK, cz

Resource Recovery x x x x | usa

Steol Mill ?Japan, USA,

Wastewater x x x x | UK, Steden'

USA, S. Africa

Mining x x x | SAS

Japan

Nuclear x x x | USA, UK,

Japan

Brewery x x [ux

Sewage* x x | USA, Sweden,

Japan

?toma Water*

Overflow x x | usa

Water Reclanation

(Purification) x x ? | Usa, Sweden

Coat Desul furization x | Usa

Medical Applications x [we

Virus Removal* x USA

Process in which magnetite seeding is used.

ose

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Boononics of Magnetic Filtration

?The costs of installed high gradient magnetic filters will obvi-

ously vary fron plant to plant, and be dependent upon, anong other factors,

the relative concentration of the waste to he treated, the flow rate of waste,

?and other site-specific conditions. ?the most thorough economic analysis of ?the process published in the Literature is for a 25 million gallon per day (ga) plant for treatment of combined sewer overflow and sewage (C50). The cost accounting was based on the results of detailed pilot plant tests (2).

?The installed capital cost of the plant including chemical ad~ ition, sludge dewatering, effluent chlorination equipment and magnetic filters was estimated at $5.187 million for the 25 nga plant. Operating and maintenance costs were estimated at $0.175 per 1000 gallons of treated water. zt is in teresting to note that of the total power cost of $0.026 per 1000 gallons only 138 4s used to operate the magnets and this is lees than one third the power

to pump water through the entire system, (45 ft head loss). Combining the capital, operating and maintenance costs, the total cost of treated effluent would be $0.234 per 1000 gallons (depreciating capital over a plant Life of

20 years at 8% annual interest rate by the capital recovery factor method) .

Te {s interesting and instructive to compare the cost per 1000 gallons of water treated in the fore-nentioned design with the operating cost ?estimated for compliance with EPA regulations by aerobic lagooning (using Surface aerators) of a 300,000 gal per day effluent having a BoD of 30,000 g/liter, a description typical of stillage from an alchoholic spirits pro- @ucing industry. Such an effluent (200 gal. /min.) would require a transfé of 37 tons of oxygen per day. A total of 1,540 horsepower of continuously functioning surface aerators rated at 2 Ibs of oxygen transfer per hour per horsepower would suffice. At an electric power cost of $0.03/kwhr it would cost in the neighborhood of $2.70/1000 gallons treated in electricity alone. ?this is certainly an exorbitant expenditure and one which few companies could absorb and yet remain competitive.

Results of Applications Carried Out to Date:

?he range of throughput capability for typical HOMP aystens is Given in Table 2. Tt is impressive to note that about 1 million gallons per

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SPECIFICATIONS OF TYPICAL. HcuP sySTENS

TPR. COOLER HATER

ixewsrons svstex | wamare FEED ?PRESSUE | POWER

WRT tenon RETR} = werowr | ane. | eunouctpur voume| pao | pur

(inches) (bs) ce2) | nance (gpm) (gpa) | _osiy | cxcivay

s62_| 206 | 126 | 170,000 z7__| s,900-19,650 9.2 | sa 75,

s20 | a7 [a2 70,000 37.8 | 2,900- 9,670 oe | 56 55.5

2 | 3, 29 45,000. 19.2 | 1,540 5,130 2.0 | 26 42.5

nm _| or 9 18,000 720 2,400, 43 | 22 35.5

ss | as ss 9,000) 360- 1,200 3.s_| 36 23

ji | ss 6. 5,900 2 200-670 26 | 22 20

2 | s2 2 2,800 0.63 |" 190-200 23 | 34 18

27 | a7 38 750 0.08 ste 4.2 ao | 9.4

?tleight measured flange to flange

Notes: The separators have a 15 cm axial matrix length and a maximum applied magnetic {eld strength of 5 kLlogauss.

To estinate filter velocity, divide desixed throughput rate by matrix area.

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ay throughput uses a matrix area of only about 2 £t7,

?ests carried out by Sala Magnetics, Inc. of Cambridge, MA. in- Gicate that typical renoval factors for several well know waste types are sufficient to bring waste streans into compliance with EPA regulations (rabie 4).

Wastes examined by CHER using Sala Magnetics and Salford Univer- sity (UK) equipment have included raw sevage, rum slops and spent beer from pharmaceutical processing. Results for all 3 wastes are sumarized in Table 5. The runs were experimental in nature and, at least in the case of run ?slope, very much better separations have been achieved since the original experiments.

TALES

waste Aten Magnetite Quantity & Renoval of

Type Cone. cone. Type of Floc 55

Raw Sewage 140 mg/l 200 mg /1 Hereoflox #91 92

0.5 mg/L

fun Slops 0 5000 mg/2 Bets 1120 mm

100 mg/1

Spent Beer 200 m/l 20 g/L Hercoflox 621 298

50 mg/L

?The CHER Survey and Program

Since magnetic filtration ie a developing technology and on-site Genonstration of its potential for pollution control of many effluent streams has not yet been carried out, CHER is actively seeking collaboration of local industries for evaluation of the technique. ?To bridge the information gap from bench test to full demonstration plants CEER is planning the use of a small capacity (10gpa) mobile magnetic filtration laboratory to be leased from Sala Magnetics. the primary objective of this 12 month project is the on-site testing of various effluent streans. To accomplish this, the traller will be stationed at selected sites of discharges in Puerto Rico for short periods. During the testing period various parameters such as quantity of seed,

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[RESULTS OF HGMP LABORATORY TESTS PERFORMED

[AT SALA MAGNETICS INC., CAMBRIDGE, MASS.

Removal

Water Type

Tabla ee

Suspended or or

solies color coo,

3 80 60-75

(eurbiaity) (coo)

95 93 90-98

seurbiaity) (coo)

(heration Stabini- 93 95 at

zation Basin) (eorbiaity) (co)

spent Beer 89 7

(evebiaity)

Surface Kater 9 99

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polyelectrolyte concentration, matrix loading, residence tines, magnetic field and flow rates will be changed to assign effectiveness of filtration parameters to each type of vaste selected by participating industries. In ?fluent and effluent will be analyzed continuously with respect to suspended solids, pit, apparent color, turbidity, settleable solids, BOD, coigoliform bacteria and heavy metals. the data obtained from this trailer will then

be utilized to develop the criteria for the applicability of HoM to treat Andustrial waste streams surveyed, to form the basis for pilot plant design ?studies and to chart future research and development direction:

Proposals for use of the trailer in pre-treatnent tests of ef-

Fluents from any industry will be discretely and cheerfully considered.

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