High Volume, High BOD Wastes: The Magnetic Separations By Dr. Arthur McB. Block, Dr. Ugur Ortabasi, and Ms. Maria Beatriz Riesco. CENTER FOR ENERGY AND ENVIRONMENT RESEARCH.

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Magnetic Separation Option By Dr. Arthur McB. Block, Dr. Ugur Ortabasi, and Ms. Maria Beatriz Riesco.

Contribution from: Center for Energy and Environment Research, University of Puerto Rico.

Introduction: The implementation of BPA "zero discharge" regulations may present problems for industries discharging unusually high volumes of aqueous wastes containing high BOD levels. Processes from which aqueous wastes contain a BOD load that does not settle readily in lagoons are also question marks with respect to new regulations. Non-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 industrial discharge.

The options usually considered viable for wastewater treatment are given in Table 1, along with some remarks which characterize some of the weaknesses in each. It should be clearly noted that in spite of drawbacks cited, each method is capable of coping with one or more than one type of waste in what is considered to be a cost-effective (or at least cost-competitive) manner.

Very recently, a 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 filtration. There are now some reasons to believe that it is an important new item in the arsenal of methodology that the wastewater treatment engineer can deploy.

TABLE 1: Treatment Technologies as Currently Practiced Treatment

Technology Comments:

Anaerobic Contact - Re-aeration of discharge required; large investment for high BOD removal.

Aerobic Contact - Odor problem. May not treat chlorinated pesticide residues.

Aerobic Lagooning - Large land areas may be required.

Surface Aerators (Clean) - Large operation 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 long sewerage lines are needed. Large, managed crop land area required.

Evaporation - Sludge transport and disposal management more urgent. Can be energy intensive. Can necessitate long hold-up times.

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 rapidly moving stream of suspended magnetic particles passes. The force felt by magnetic materials in the stream allows for the efficient separation or filtration of even weakly magnetic suspended solids. High gradient magnetic separators are designed to maximize the force for precipitates for which conventional magnetic separation techniques are ineffective. This capability is the result of the development of a filamentary ferromagnetic matrix and a large volume, high-field magnet. The combination of an efficient magnet and high gradient matrix permits the economical generation of strong magnetic forces over a large surface area in the magnetic filter bed (Figure 1). Filtration can be carried out economically, and at process rates of up to several hundred gallons per minute per square foot of fluid stream cross-section (gpm/ft^2). Large scale industrial applications of this technology already exist for wastewater treatment in steel mills and steam condensate treatment in paper mills. Numerous large installations also exist in the clay industry for the separation of fine impurities from clay slurries. For normally nonmagnetic colloidal particles, this technology can be utilized effectively.

Material in polluted water can be removed through the addition of magnetic iron oxide powder (magnetite) combined with a coagulant. This forms a combined particle sufficiently magnetic to be removed by high gradient magnetic filtration. The machines used for this process provide rapid filtration of many pollutants from water with a minimal expenditure of energy. They are more efficient than sedimentation as the magnetic forces on fine particles are significantly greater than gravitational forces.

Municipal and industrial wastewater treatment using high gradient magnetic filtration with iron powder seeding is under active development in several countries. Applications of this method include treating combined storm and sewer overflow, raw sewage, and wastewater from paper, petrochemical, and other industries. A summary of applications, their respective states of development, and the country of development is provided in Table 2.

FIGURE 1: High Gradient Magnetic Separation Filter Showing Section of Matrix Wire

Table 2: Gradient Separation and Filtration Applications State of Full-Scale Development

Application	Full scale	Development	Research	Country
Boiler Water Treatment	x	x	x	USA, Japan, USSR

Chlorine	x	x	x	USA, UK, CZ
Resource Recovery	x	x	x	USA
Steel Mill Wastewater	x	x	x	Japan, USA, UK, Sweden
Mining	x	x	x	USA, S. Africa, SAS, Japan
Nuclear	x	x	x	USA, UK, Japan
Brewery	x	x	-	UK
Sewage*	x	x	-	USA, Sweden, Japan
Storm Water Overflow*	x	x	-	USA
Water Reclamation (Purification)	x	x	-	USA, Sweden
Coal Desulfurization	x	-	-	USA
Medical Applications	x	-	-	EU
Virus Removal*	x	-	-	USA

*Process in which magnetite seeding is used.

Economics of Magnetic Filtration

The costs of installed high gradient magnetic filters will obviously vary from plant to plant and are dependent upon several factors, including the relative concentration of the waste to be treated, the flow rate of waste, and other site-specific conditions. The most thorough economic analysis of the process is published in the literature.

TPR. Cooler Hater Excursions System | Hardware Feed 'Pressure | Power WRT Tendon Retract | Arrow | Ante | Conductive Volume | Psi | Psi (inches) (lbs) (ce2) | Nuance (gpm) (gpa) | _osity | Excivay s62_ | 206 | 126 | 170,000 27__ | 8,900-19,650 9.2 | SA 75,520 | A7 | A2 70,000 37.8 | 2,900- 9,670 0E | 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 3.5 | 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 'Height measured flange to flange

Notes: The separators have a 15 cm axial matrix length and a maximum applied magnetic field strength of 5 Kilogauss. To estimate filter velocity, divide the desired throughput rate by matrix area.

Throughput uses a matrix area of only about 2 ft7. Tests carried out by Sala Magnetics, Inc. of Cambridge, MA indicate that typical removal factors for several well-known waste types are sufficient to bring waste streams into compliance with EPA regulations (Table 4). Wastes examined by CHER using Sala Magnetics and Salford University (UK) equipment have included raw sewage, rum slops and spent beer from pharmaceutical processing. Results for all 3 wastes are summarized in Table 5. The runs were experimental in nature and, at least in the case of rum slops, very much better separations have been achieved since the original experiments.

Table: Waste Type | Magnetite Cone. | Quantity & Removal of Type of Floc
55 Raw Sewage | 140 mg/l | 200 mg/l Hercoflox #91 | 92 0.5 mg/L

Rum 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 is a developing technology and on-site demonstration 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 to use a small capacity (10 gpa) 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 streams. To accomplish this, the trailer 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,

[RESULTS OF HGMP LABORATORY TESTS PERFORMED AT SALA MAGNETICS INC., CAMBRIDGE, MASS. Removal Water Type Table ee Suspended or or solids color coo, 3 80 60-75 (turbidity) (coo) 95 93 90-98 (turbidity) (coo) (Filtration Stability- 93 95 at zation Basin) (turbidity) (co) Spent Beer 89 7 (turbidity) Surface Water 9 99 9

Polyelectrolyte concentration, matrix loading, residence times, magnetic field, and flow rates will be changed to assign effectiveness of filtration parameters to each type of waste selected by participating industries. Influent and effluent will be analyzed continuously with respect to suspended solids, pH, apparent color, turbidity, settleable solids, BOD, coliform 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 industrial waste streams surveyed, to form the basis for pilot plant design studies and to chart future research and development direction. Proposals for the use of the trailer in pre-treatment tests of effluents from any industry will be discreetly and cheerfully considered.

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1. Block, A. McB. "The Human Waste Problem in