Suspended Particle Extractor (SPX) For Removing Oil and Oily Wastes From Water

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Within recent years new and significant importance has been placed on the disposal or reuse of water in our industry. Generally the waters involved contain oil in particulate and emulsified form together with oil-wetted debris of one kind or another. For disposal into rivers and oceans, the oil content must be reduced to 20 ppm or less; for injection or reuse, the oil content frequently must be reduced to less than 1 ppm. Conventional separation procedures alone (e.g., skimming, filtration and etc.) are seldom adequate or are impractical to employ for such stringent requirements.

In view of the wide range of problems we encounter in water processing, our company initiated an R&D program in 1966 with the goal of developing a generally versatile process for water treatment. A considerable effort was spent to determine proper chemical treatment to con-

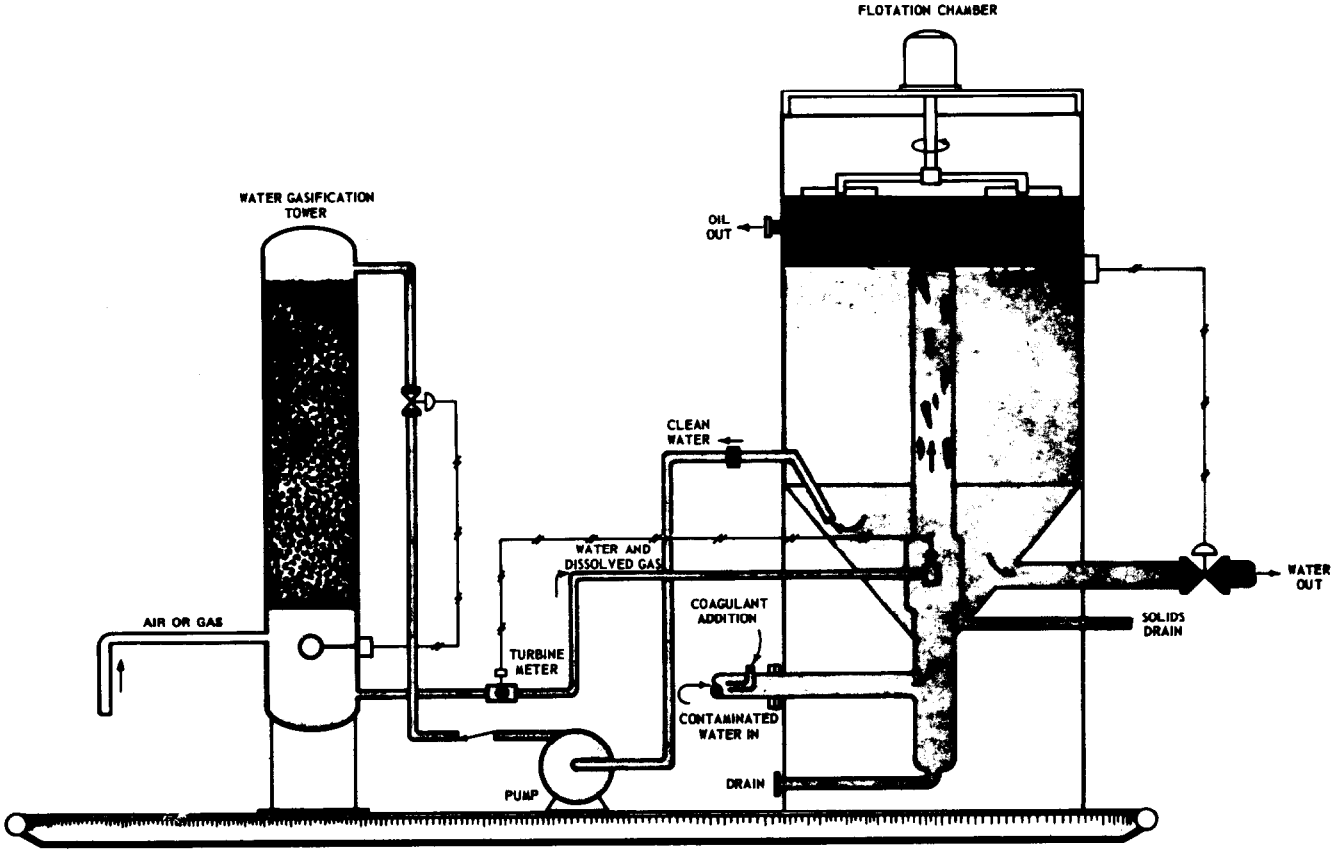

FIGURE 1

SPX FLOTATION SYSTEM

dition water from different sources so that the oil and water could ultimately be separated by some mechanical means. Further studies were conducted to gain insight as to proper handling procedures in order to avoid problems resulting from mechanical emulsification of entrained oil. Plastic working models of various separating systems were employed to evaluate the adaptability of each system to the pretreatment procedures which we felt would be generally applicable. These efforts culminated in a flotation system shown diagramatically in Fig. 1.

In the SPX system, contaminated water rises through a centralized flume of the flotation chamber and large quantities of micro bubbles are admixed with the water while contained within the flume. Bubble attachment of oil particulates (or chemically agglomerated oil) causes the oil to rise to the surface where it is removed by mechanical means. Clean water is drained from the bottom of the flotation cell in such a manner as to maintain a constant height of the water-oil-air interface. A recycle stream of the clean water is taken from the effluent of the cell, pressurized and fed to a contactor tower where it is saturated with a suitable gas at an elevated pressure. Water, with gas in solution, is taken from the bottom of the contactor tower and fed to a micro bubble release mechanism situated

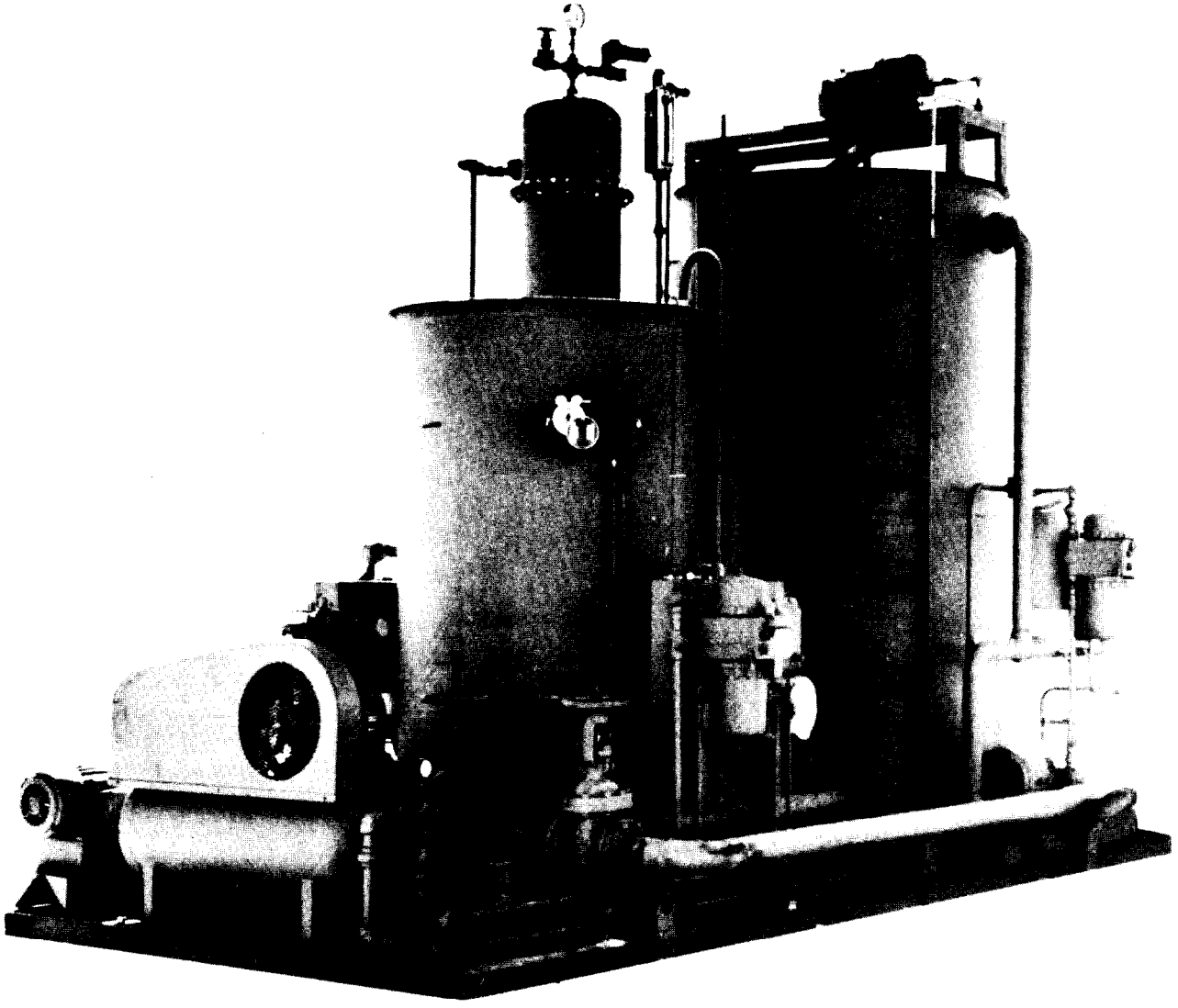

FIGURE 2
SPX PILOT UNIT

in the flume of the flotation chamber. The released bubbles are then admixed with the contaminated water in such a manner as to avoid undue bubble coalescence.

It can be noted that this system does not require a pump to feed contaminated water to the flotation cell. In general, we have found that gravity-feeding the unit is preferred wherever possible in order to avoid shearing entrained oil droplets to particle sizes too small for bubble capture. In the event that a pump is necessary to apply a proper head for operation, a positive displacement unit is desirable. In locations requiring a centrifugal pump, the resulting mechanically-produced emulsification can usually be broken by adding fast-acting agglomerating chemicals.

Figure 2 is a photograph of one of the four SPX pilot systems that have been tested throughout the oil producing areas of the United States. The units will handle about 3700 BWPD (100 gpm) for a hydraulic loading factor of 171 BPD per square foot of cell cross-sectional area. Depending upon certain variables the recycle rate (to provide bubbles) is from 10 to 20 per cent of the cells rated through-put. The recycle stream can be considered a captive stream and thus circulates to supply adequate bubbles even though the plant throughput varies from 0 to 100 per cent rated capacity. The amount of gas used as a flotation medium averages about 20 SCF per thousand barrels of water treated. Calculations indicate that each gallon of contaminated water may be permeated with literally millions of bubbles of gas in the 40 micron diameter range.

Separation of oil, iron sulfide and other oily debris from the contaminated water can be accomplished quite readily by flotation procedure providing proper pretreatment of the water is provided for. Our experience has indicated that a primary coagulant together with a flocculating aid are generally sufficient to pretreat any water of interest and it is usually possible to lower the total oil count in the effluent water to a few ppm. With proper choice of coagulant and dosage any oil in the SPX effluent is tied up as a solid particulate and hence can be completely removed by filtration procedures to give an oil-free, solids-free product.