A large amount of pilot plant work is proposed to investigate treatability of each of the wastewaters. Reason could likely reduce the proposed flow schematics to a more manageable number.

Anaerobic treatment, where proposed, should address the expected sulfide levels in the wastewater and anticipate the addition of iron to precipitate metal sulfides. In addition, pH adjustment should be considered where wastewater has a low pH value. Aerobic biological treatment is occasionally shown on process schematics following anaerobic treatment. This order of process may be inadvisable if odors will be a problem in the area under consideration.

Several wastewaters exhibit significant BOD. To treat them aerobically would likely require a pure oxygen system. The authors rightly contend that high solids content in the activated sludge system will provide increased BOD removal efficiency. Along with a modest efficiency increase, high solids content (+4000 mg/l) in the activated sludge system will result in problems for the plant operator.

The flow diagram for aerobic biological treatment shows a roughing filter ahead of the complete mix activated sludge plant. The trickling filter can perform effectively, but peak loadings will be passed through the filter on to the activated sludge system.

The authors do not mention the handling of treatment sludge. Neither do they address the need for wastewater equalization ahead of any treatment process. Most of these wastewater flows should be fairly continuous, but if any batch processing is necessary, the need for equalization basins should be considered.

The following comments concern the four pilot plant investigations proposed for: hydropulping waste, scrubber water, pyrolysis wastewater, and digester filtrate. Assuming surface water criteria of approximately 30 mg/l for both BOD and suspended solids, the aerobic plant could likely meet most surface water discharge criteria. On the other hand, the anaerobic processes would do a good job as roughing treatment, but would need to be followed by physical-chemical treatment to meet surface water criteria. As an alternative to physical-chemical treatment, the anaerobic process could be followed by an aerobic or activated sludge plant to meet surface water criteria.

One would not expect a need for physical-chemical treatment on the hydropulping waste stream unless there is a significant metals content in the influent wastewater.

The treatment proposed for the scrubber water appears excessive. It is likely the physical-chemical pilot plant would demonstrate adequate treatment for this waste.

Table 3 shows BOD concentrations higher than those for COD. Obviously, this is in error and should be corrected. The treatment schematics in Fig. 3 for the pyrolysis wastewater include physical-chemical treatment, which must be for heavy metals...
removal. The text states that presence of heavy metals in pyrolysis wastewater has not been identified. This should be verified before a pilot study is undertaken for physical-chemical treatment.

Treatment of digester filtrates as shown in Fig. 4 could be accomplished with activated sludge and the need for physical-chemical treatment is questionable. Physical-chemical treatment alone would probably not be adequate to meet effluent criteria. It appears that digester filtrate could be adequately treated with aerobic biological treatment consisting of pure oxygen activated sludge preceded by an equalization basin if BOD concentration fluctuations are expected. Regular air activated sludge could be used if the BODs are relatively low.

AUTHORS' REPLY

The two major purposes of this paper were: (1) to conduct a thorough literature survey of reported pollutants identified in WAF facilities; and (2) to recommend treatment processes which could reduce the pollutant levels to values acceptable for discharge to a publicly owned treatment works (POTW) or to ambient surface waters. Tables 1 through 4 summarize the significant pollutants identified in four major WAF process streams. For most processes, a range of values have been reported for each of the pollutants, corresponding to values reported by different investigators. The range of values is caused by many variables, such as influent water quality, process design and operating parameters, sampling point and time. The importance of the ranges given lies not in their absolute value, but rather in the order of magnitude concentration expressed for the various pollutants and the presence, or absence, of data on the pollutants. In Table 3 for example, the values for the BOD's and COD's were taken by different investigators at different sites and do not represent the simultaneous determination of the effluent BOD and COD on particular samples. If the COD of a particular sample was determined along with the BOD, then obviously the COD value will be greater.

Having gathered the available information on pollutant concentrations, the next step was to recommend treatment processes which would render the potential waste streams amenable to discharge. At a particular plant, only one process train, such as aerobic, or anaerobic or physical-chemical, may be required, depending upon the waste stream characteristics at that plant. However, because of the wide range of possible pollutant values for each WAF process, treatment trains were recommended which could successfully treat the full range of values. The purpose of the pilot plant testing is to compare the feasibility and removal levels obtainable by the various liquid processing steps. The pilot plant itself would withdraw only a small portion of the total wastewater flow from the WAF facility and consequently no provisions are made for plant peaking. Similarly, in line with the objectives of evaluating the removal efficiency from the liquid waste stream, no provision was made for sludge dewatering and disposal.

A comparison of the range of pollutants, shown in Tables 1 through 4 with the expected removal efficiencies shown in Table 5, indicates that a single treatment process, whether it be aerobic, anaerobic or physical-chemical, is probably not going to adequately remove organic surrogates below the surface water criteria of 30 mg/l. In many instances, a 90 percent removal efficiency for organic surrogates would still leave an effluent containing between 100 and 1,000 mg/l of BOD or suspended solids. These residual materials would probably be refractory organics, which could successfully be removed in a tertiary physical-chemical process to levels below surface water discharge criteria. The presence of refractory organics dictates the utilization of the physical-chemical pilot plant as a final removal phase.

In summary, determination of a particular treatment technology for a WAF waste stream was complicated by inadequacy of waste stream characterization. In most of the WAF facilities, the project manager was concerned with obtaining an operational WAF facility: characterization of liquid waste streams was a low priority item. The treatment technologies recommended are necessarily conservative in order to handle the range of pollutants identified at the WAF facilities. The treatment trains actually employed at a particular site must be evaluated on a case-by-case basis so as to avoid treatment redundancy and unnecessary expense.