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Sodium Carbonate Salt Transport System

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Sodium Carbonate Salt Transport System

Background

A sodium carbonate salt transport system is required to support the Molten Salt Oxidation system being constructed at Lawrence Livermore National Laboratory. We are embarking on a project to create a national test bed for evaluating mixed waste destruction technologies. This project is called the Mixed Waste Management Facility. It is currently in the second phase of design and will be operational in 1998. One of the first technologies demonstrated in this facility is Molten Salt Oxidation.

Molten Salt Oxidation is a thermal process that destroys the organic constituents of mixed and hazardous wastes, Figure 1. Sodium carbonate salt is heated in a reactor vessel to approximately 950° C. Organic wastes, along with oxidant air, are injected under the pool of molten salt. A catalytic reaction occurs converting the organics into CO_2 and water. Inorganic constituents in the salt such as metals, silica, alumina, and radionuclides remain captured in the salt. Chlorides in the waste feed are converted in the salt to sodium chloride. As these impurities build up in the salt, the salt must be recycled to remove them or else the reaction rate is reduced. Spent salt is periodically taken from the reactor and transported to a salt recycle system. In this system the molten salt is freeze-dried, dissolved in water, and filtered to remove the insoluble inorganics. The unconverted sodium carbonate is removed by fractional crystallization. This sodium carbonate is then dried and stored for future use in the reactors, eliminating a secondary waste stream. The remaining brine is disposed of as waste.

Our molten salt oxidation system consists of three reactor vessels, approximately 40cm in diameter and 350cm tall. Each will contain approximately 275 kilograms of sodium carbonate salt. The total throughput of these three reactors will be 20 kilograms of chlorinated organics per hour. This will produce 26 kilograms of sodium chloride per hour which must be separated from the sodium carbonate bed. After the mixed spent salt has been reprocessed, the sodium carbonate will be recycled to the reactor vessels. This requires a transport system. This transport system will receive the sodium carbonate from a single large feed hopper and distribute it on demand to the three individual feed hoppers atop each reactor vessel. The transport system shall be capable of supplying sodium carbonate to one reactor at a time. The required feed rate is 75 kilograms in five minutes. It will be cycled approximately once per hour per reactor. Since salt has been in contact with hazardous and radioactive materials, it must be considered hazardous. Therefore, the system must be enclosed to prevent salt dust from contaminating other equipment. The transport interfaces are the supply hopper and the three receiving hoppers. When designing the system, consideration of maintainability is essential. Bear in mind that although the salt has been processed, it still contains traces of hazardous material and direct human contact is undesirable. Figure 2 shows an isometric arrangement of the system. Note that the major components are in enclosures which will contain glove ports for access. We are looking for a conceptual design, therefore structural and seismic calculations need not be made. The relative locations of the salt hopper and individual feed hoppers shown in Figure 3a & b. A desirable feature of this system is to keep feed batches of salt separated i.e., the ability to empty or drain the system when the salt received from the salt recycle system is generated by a significantly different waste stream.

Problem Statement

Conduct a conceptual design study resulting in a salt transport system conceptual design and cost estimate.

Approach

Conduct a conceptual design study by researching several concepts. This will include transport methods, conceptual designs, and the sizing and specifying of commercial or special equipment.

Conduct a cost estimate study. Include all equipment: custom designed, modified commercial, and off-the-shelf. Vendors and suppliers can provide good budgeting numbers based on sketches. In many instances they have run into similar situations before and can provide good ideas.

Factors such as reliability and maintainability are extremely important. They relate to the economics of operation of a piece of equipment. Reliability involves how often a system goes down due to the failure of a component. Maintainability is a relative measure of the maintenance or repair of a system. State the factors you feel most important and why.

Select the system most likely to succeed based on cost and other factors. The cost is an absolute factor whereas your other factors are subjective. Establish your ranking criteria and state your assumptions. There are no wrong answers.

Help

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Figure 1
MSO thermal process system

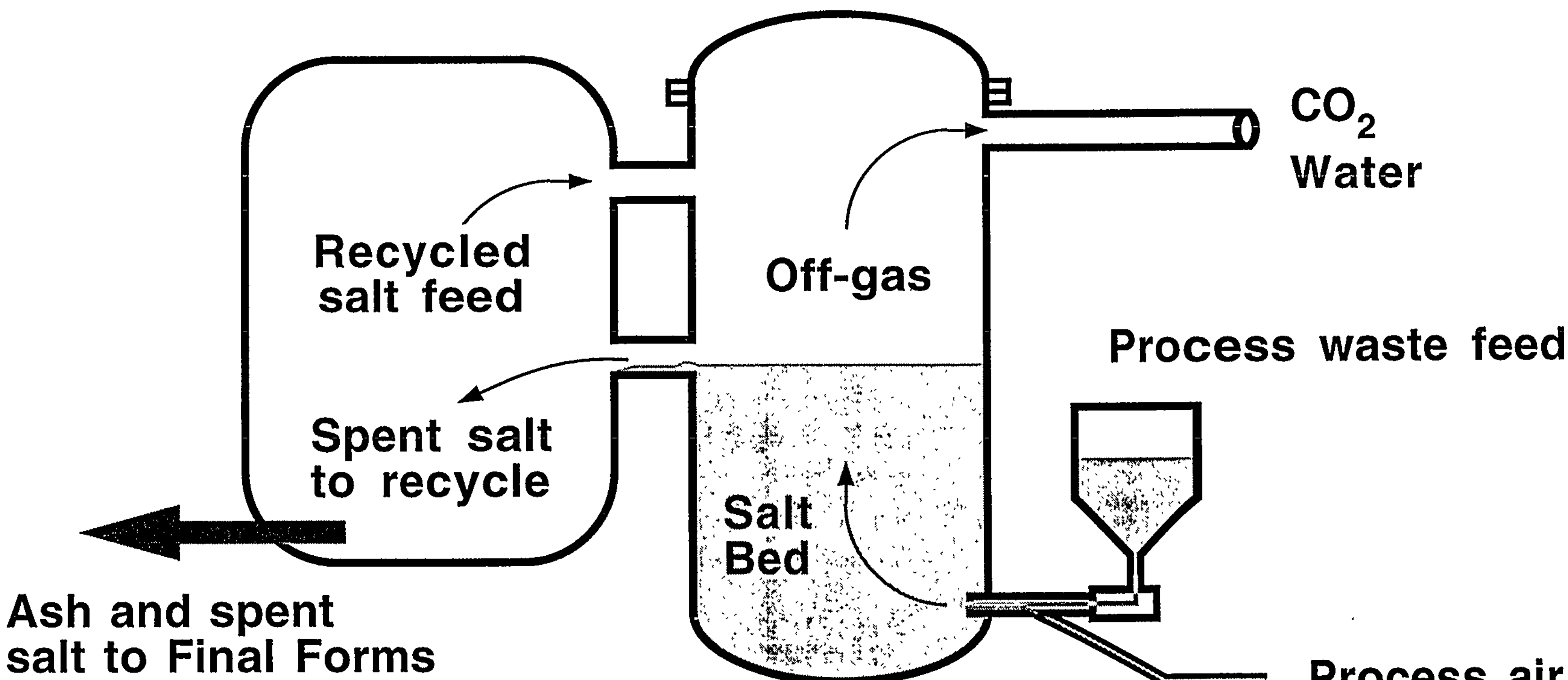


Figure 2
MSO Arrangement

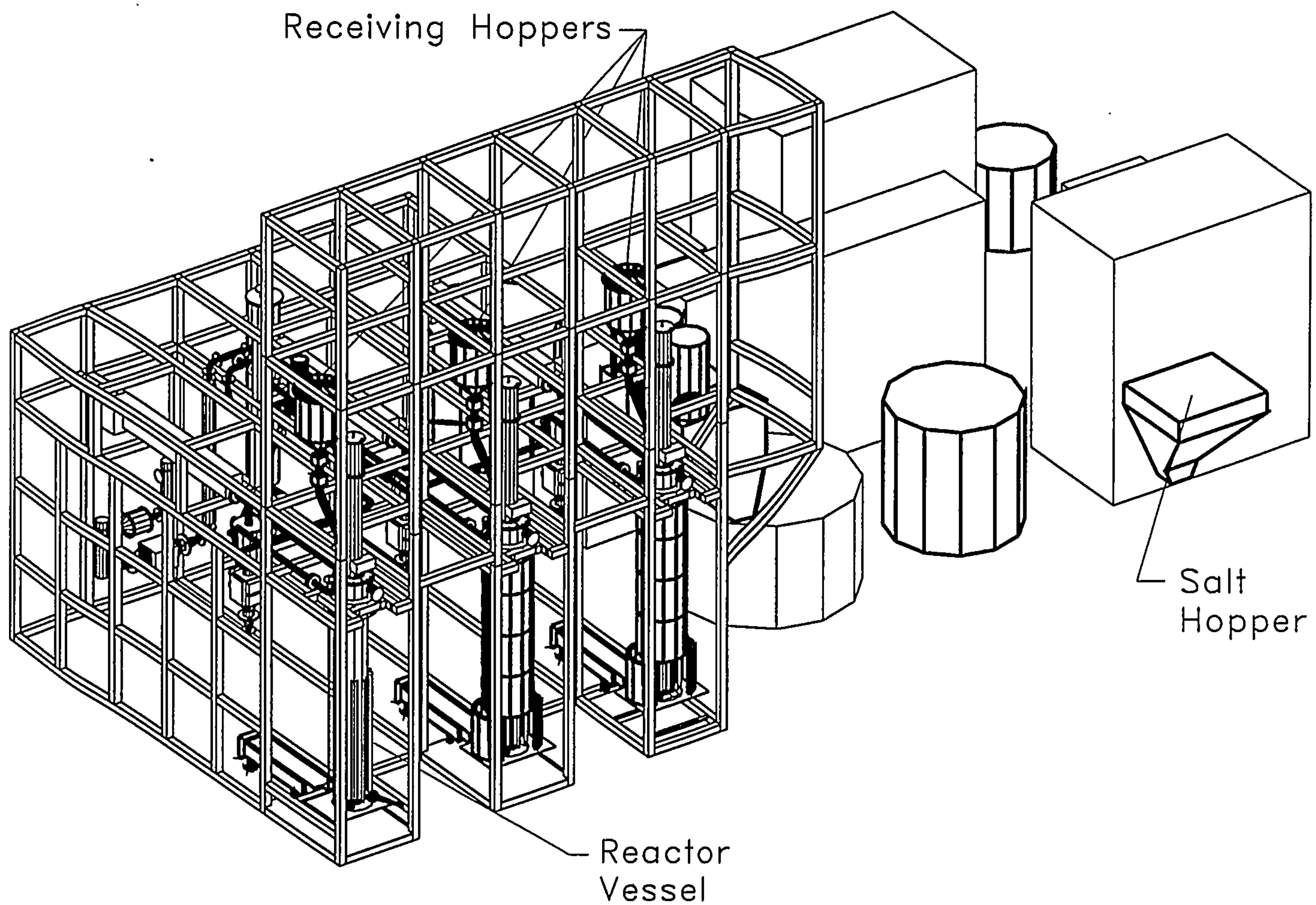
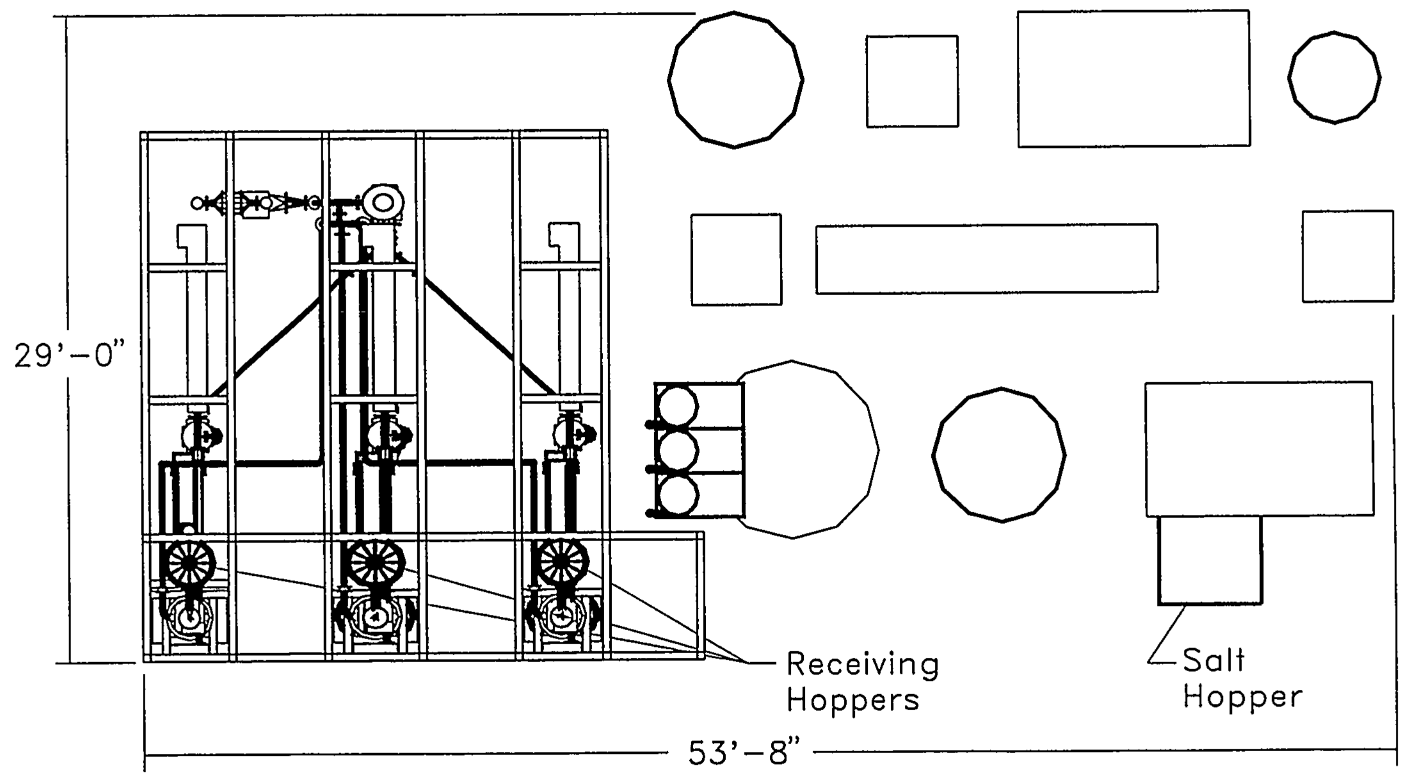


Figure 3A
MSO Plan View



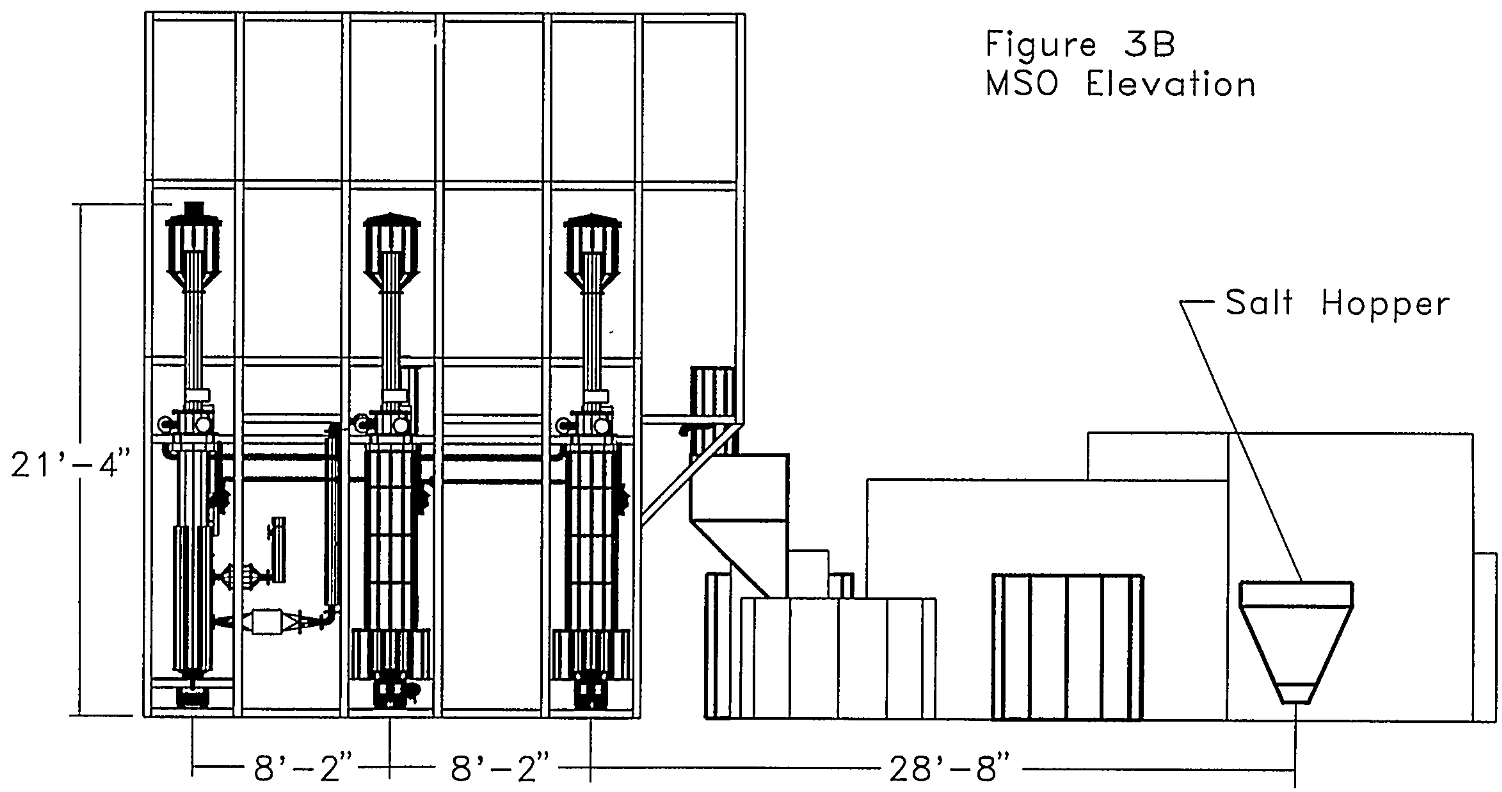


Figure 3B
MSO Elevation