CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

From the experiments done, the following conclusions and recommendations were drawn:

1. The combustion of oil shale and lignite mixtures in a fluidized bed combustor is possible. The ash fusion will not occur as long as the fuel feed rate and the fluidizing air velocity are properly tuned. The experimental results throw a light on the application of oil shale and lignite mixtures as solid fuel for the power plants on the locations where these fuels are presented adjacently or co-originally. Furthermore, they lead to the utilization of oil shale, which is a low grade and difficult-to-ignite fuel, concomittant with typical lignite to compromise the lower combustion efficiency, high carbon monoxide and sulfur dioxide emissions in case of pure lignite burned, and ignition difficulty and high nitric oxide emission in circumstance of pure oil shale combustion. More investigations are required for scale-up or plant design purposes.

2. The combination of excessive moisture and fines may clog up the FBC solid feeding system. This is particularly true when the combusted fuel was lignite. The preheat treatment of lignite is necessary to drive off the excessive moisture, particularly in long-term operation.

3. Carbon combustion and desulfurization efficiencies increase along with oil shale to lignite weight ratio of the fuel feeds.

4. For each oil shale to lignite ratio, combustion efficiency decreases as excess air and/or particle size increase(s) while desulfurization efficiency increases. Thus, there should be an optimum excess air and particle size for the combination of combustion and desulfurization efficiencies.

5. Elutriated carbon plays a major role in the emissions of carbon monoxide and nitric oxide while bed temperature seems to be less influential.

6. Not only calcium to sulfur ratio of the fuel mixture, but also the excess air, has a great effect on the reduction of sulfur dioxide emission.

7. The optimum oil shale to lignite ratic for acceptable emission of SO_2 and NO (0.2 to 1.2 $lb/10^6 Btu$ for 85% removal and 0.6 $lb/10^6 Btu$ respectively, according to EPA New Source Performance Standrd for AFBC plants)[43] was found to be about 3.0.

8. The by-passing in form of bubbles of the nascent air will reduce the oxygen consumption efficiency. Thus, the art of distributor design is absolutely significant and desirable.

9. Oil shale has a high inert solids content. For maximum heat recovery and ease of handling, it is desirable to extract the sensible heat from the spent bed material. The sensible heat in the spent bed material may be used to preheat the incoming fluidizing air or to dry the lignite feed. The typical moving bed heat exchanger for waste heat recovery, where tube bundles are inserted into the moving bed, and direct contact method, are proposed.

10. A two-stage combustion process appears highly desirable to provide:(14,30)

- Sufficient temperature gradients existing in the combustion system to allow for devolatilization and calcination at different locations within the reactor. This is desirable to separate devolatilization, which is an exothermic reaction, from calcination, which is an endothermic reaction. The calcination of oil shale may be unnecessary for desulfurization because the calcium spreads through out the particle and combustion will provide a higher porosity for gases diffusion.

- Provision for maximum heat recovery from the solid and gaseous effluents, to increase overall energy conversion efficiency.

- Nitric oxide reduction.

Nevertheless, the typical solid-handling system can become so complicated that it compromises operation reliability. A typical two-staged FBC system is shown in

Figure 7.1

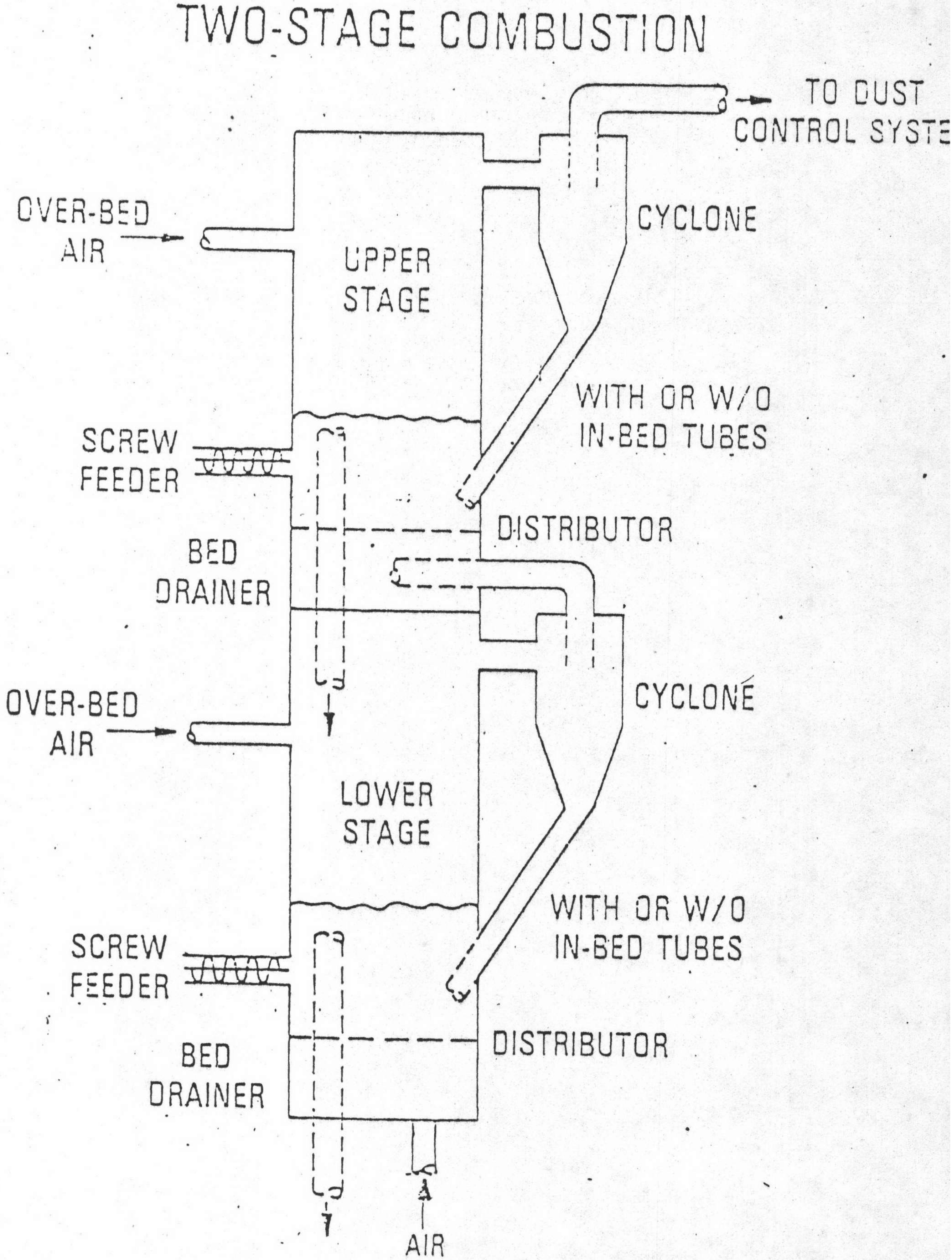
TWO-STAGE COMBUSTION
TO DUST CONTROL SYSTE
OVER-BED AIR
UPPER STAGE
CYCLONE
WITH OR W/O IN-BED TUBES
SCREW FEEDER
DISTRIBUTOR
BED DRAINER
OVER-BED AIR
CYCLONE
LOWER STAGE
WITH OR W/O IN-BED TUBES
SCREW FEEDER
DISTRIBUTOR
BED DRAINER
AIR

Figure 7.1. The number of vulnerable points which may cause solid handling problems is easily observed. An improved design concept would utilize a fluidized-bed system with a high freeboard. A dense dust cloud would form over the burning fluidized bed where the temperature is high enough for combustion stability, yet low enough to avoid excessive calcination. The volatile material emitted from the combustion fluidized bed would pass into and through the dust, and burn in the freeboard region. The dust cloud would be thick enough to attenuate the heat which could be transmitted by radiation from the freeboard to the burning fluidized bed and convective/conductive would be negligible.

11. The art of bed temperature control using in-bed water tube is an interesting item for future work.