ABSTRACT

The present study was undertaken to identify a suitable candidate fertiliser salt for use in salt gradient solar ponds. The studies on status of fertiliser consumption in India and salinity-density characteristics of the selected fertiliser salts identified Muriate of Potash (MOP) as a suitable candidate salt.

A test rig was developed to test the suitability of any candidate salt for its applicability in the solar ponds with provision to vary lower convective zone temperature and heat flux. The chosen salt was studied under simulated conditions under different lower convective zone temperatures and heating modes. A comparative evaluation of the performance of MOP with sodium chloride and saltless solar ponds was conducted under identical simulated conditions. The formation of the three zones viz., upper convective zone, nonconvective zone, and lower convective zone was distinct at all heating combinations for both MOP and sodium chloride salts under simulated conditions.

In addition to laboratory simulation studies, a comparative performance of MOP and sodium chloride solar ponds was evaluated under real conditions (keeping saltless pond as control) and the heating up process of solar pond using these salts was studied over a period of 45 days. Any possible side effects and effect of climatic factors like rainfall on the salinity gradient of the solar pond were studied during the period of this study. The performances of MOP and sodium chloride solar ponds were found to be at par under real conditions statistically. The efficiency of MOP solar pond was found to be in the range of 10 to 21 per cent during the period of solar pond operation. The MOP solar pond generated a maximum LCZ temperature of 52.7°C on 27th day of operation.

A model was developed to predict the performance of solar ponds over a longer period. The model predicts the temperature and salinity profiles on hourly basis. The model was validated for the data obtained during performance evaluation of MOP solar pond under real conditions. The model was further extended to predict the performance of MOP, sodium chloride and urea solar ponds over a period of two years. Using the proposed model, for Calcutta location, maximum lower convective zone temperature

would occur in June of second year of operation, irrespective of the starting month of pond operation for all the three salts. The maximum lower convective zone temperatures predicted for MOP, sodium chloride and urea solar ponds were 100.1° C, 94.8° C, and 91.7° C respectively.

A thorough economic analysis was made to determine the suitable solar pond sizes for different agricultural process operations involving application of hot water. The MOP salt gradient solar pond appeared to be more economical (Rs 0.84/kWh) than sodium chloride solar pond (Rs 1.39/kWh).

The selected salt MOP, apart from being farmer friendly, obviates usual environmental threat associated with sodium chloride, provides stable fertiliser supply for the agricultural purposes, and acts as an energy reservoir supplying the power at a very competitive price.

Key words: Solar pond, Muriate of Potash, Fertiliser, Sodium chloride, Saltless, Temperature gradient, Salinity gradient, Simulation, Real conditions, Modelling, Performance prediction, Economics, Pond size, Spreadsheet program, Agricultural processes