CHAPTER V

SUMMARY & CONCLUSIONS

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In the present investigation we have developed cobalt oxide coating in the form of thin film on Aluminium and Stainless steel substrates by spray pyrolysis technique. The different preparative parameters were optimised. The structural and optical properties of cobalt oxide coating were studied. Further its application as a solar thermal converter was also studied.

In the first chapter introduction of different energy sources, availability of solar energy, the various ways of converting this solar energy, thermal applications of it, literature survey of various selective coatings and purpose of dissertation are given. In the second chapter the spray pyrolysis method is described in detail with its experimental set up. Also the deposition of cobalt oxide, its structural and optical study is given. In the third chapter theoretical background of thermal absorption, studies on cobalt oxides as solar thermal absorber are given. The cobalt oxide coating as a good thermal converter is discussed in chapter four. The fabrication of solar thermal converter, the experimental setup with and without concentrator are also discussed. The results are summarised below.

The optimum air pressure for good quality, uniform, reproducible cobalt oxide films is 0.5 to 0.6 kg/cm^2. The height of nozzle tip from substrate should be 23cm. While spraying the cobaltous acetate solution the substrate temperature for aluminium should be 300°C while for stainless steel it should be 400°C. We could not have the deposition on copper substrate. The proper concentration of solution is observed to be 0.075 M. From microstructure study it is seen that on both aluminium and stainless steel substrates the grain size of cobalt oxide molecules is observed to be increased with heating. In case of aluminium the intermolecular distance increases after heating. But on stainless steel it decreases. After heating upto 500°C the films of cobalt oxide on aluminium and stainless steel are not found to be destroyed in any sense. Hence they are stable even at higher temperature of the order of 500°C.

The X-Ray diffraction pattern of cobalt oxide deposited on stainless steel substrate exactly matches with the published data. So it confirms that the deposited films are of cobalt oxide.

The percentage reflectance decreases when the substrates are coated. It is very much uncertain in both very low and very high wavelength regions. When heated, the percentage reflectance get reduced hence the absorptance increases. So it is necessary to heat the coated films for better absorption and efficiency.

From study of the variations of temperature with time for different quantities of solution sprayed, it is clear that for 150 ml solution of cobaltous acetate mixed with 75 ml iso-propyl alcohol, the rise in temperature for both aluminium and steel substrates is regular. No fall of temperature is observed. Also the coated film of cobalt oxide on stainless steel substrates show more rise in temperature as compared to that on aluminium substrate. For this study small thermal absorber cells were fabricated.

The design of solar thermal converter helps to avoid the losses of thermal energy due to wind effect.

The solar thermal converter was tested in different modes such as steel without coating without concentrator, with coating without concentrator, without coating with concentrator, with coating with concentrator. The temperature rise is more in coated steel. Without concentrator, in case of coated steel temperature rises and then remains constant. While in case of plain steel it increases, remain constant and then decreases. Hence, saturation occurs in coated steel.

When Fresnel lens as concentrator is used, the rate of rise of temperature increases. The rate in case of cobalt oxide coating on steel is considerably high as compared to rate on plain steel. It required 25 minutes on plain steel to raise the temperature to 50°C while on coated steel with concentrator the water boils within just one and half minute.

Similarly the converter on parabolic concentrator shows a better rise in temperature. Here the temperature raised from 32°C to 96°C within 15 minutes. The temperature was found to decrease with increasing input flow rate of water. But for low rate 100 cc/min we can get steam.

The efficiency of solar thermal converter was also calculated for different modes. It is found to increase with coating of cobalt oxide and use of concentrator. It is maximum 47.55% for the converter with cobalt oxide coating on steel and operated under the concentrator.

The intensity of sunlight varies instantaneously. The maximum intensity recorded on that day was 110 mW/cm^2.

When the concentrator is used the temperature rises suddenly. It is because of concentration of incident energy to a comparatively very low area. Due to this water get boiled within just 90 to 100 seconds. The solar energy available on that day was 3.7728 kJ/m^2-day.

The necessity and some details of the tracking system is also discussed.

In conclusion it is seen that cobalt oxide is a very good solar thermal absorber stable even at high temperature. It produces steam which can be stored. With the help of this steam we can generate electricity. A solar thermal power station can be operated as a large scale application of this selective coating.