INTRODUCTION

Fossil fuels such as oils, natural gas and coal supply more than 90% of world's energy needs today. For many years fossil fuels were regarded as an endless source of cheap energy, and only in the recent past, people have become particularly aware of the limited oil and natural gas supplies. Fossil fuels represent a non-renewable natural resource and the cost is rapidly escalating as the world energy demand continues to increase due to population growth and technological development (Zajic et al., 1978 b). International problems with air pollution have raised public awareness to the need for non-polluting energy sources. Hydrogen has, in the past, been suggested as a fuel which would eliminate air pollution problems, it is an important alternative fuel source which represents a highly efficient energy carrier, and compares favourably with other fuels which are available today (Huang et al., 1985). However, many complications still exist before hydrogen can be accepted. One reason for the delayed acceptance of hydrogen has been the difficulty of its production on a cost effective basis and another reason is its storage.

The industrial wastes (distillery effluents and whey) which are available in abundance pose environmental pollution problems, are good feedstock for producing a non-polluting energy source, hydrogen with concomitant reduction of pollution in terms of COD and BOD and it becomes a part of treatment strategy. Classical biological treatment systems rely on
microorganisms able to utilise the pollutants as growth substrates, thereby removing dissolved and suspended organics from the wastes (Wyatt, 1988).

In the present investigation, different industrial wastes were used as substrates for hydrogen production by Citrobacter freundii. Physical parameters like dilution, aeration and pH effect on hydrogen production by C. freundii from industrial wastes were presented. Effect of formate on hydrogen production by C. freundii was also presented. Thermodynamic efficiency is analysed with co-culture systems using photosynthetic (Rhodospirillum rubrum ATCC 11170 and Rhodobacter capsulatus ATCC 11166) and non-photosynthetic (C. freundii) bacterial systems. Generally, the emphasis is given to augmentation of hydrogen production and pollution reduction.