CHAPTER 1

INTRODUCTION

India has witnessed rapid industrial growth during the post liberalisation. The textile industry with a 25 % share of the overall exports is one of the main foreign exchange earner. In 1999, 20 % of India's industrial output were contributed by the textile industry. On one hand industrial and economic growth is supported on a large scale in different sectors, on the other hand pollution of the environment is not sufficiently controlled and unchecked exploitation of resources such as groundwater nullify the effects of industrial growth.

The textile processing industry (TPI) is characterised by its fairly high specific water consumption and its large amount of wastewater discharges. The discharge of effluents is problematic in both quantity and quality causing environmental pollution. The specific effluent discharge, for example, varies, according to the production method, between 40 m³ and 300 m³ per ton of substrate and contains:

- High Total Dissolved Solids, TDS because of fixation salts
- Intense colouring, caused by large amounts of unfixed remaining dyes
- High pH, temperatures, many reactions required caustic conditions at high temperatures.
- AOX-, Sulphide- and heavy metal concentrations

Some substances can have toxic effects on the receiving environment such as APEO (Alkylphenol Ethylene Oxide adducts), which after metabolism is fish toxic. Looking at all Indian hosiery garment exports, the city of Tirupur in western Tamil Nadu State, south-central India is India’s knitwear capital. Tirupur’s name means
“holy city,” and its Saiva temple attracts large crowds of pilgrims, especially at the
time of the Hindu Rathayatra (chariot festival) celebrated in May and June. Tirupur’s
share in quantity increased from 21 % in 1984 to 51 % in 1998 and in terms of value
from 11% to 40 % of the total Indian export. Tirupur is an active cotton knitwear
centre with 305,546 inhabitants in its metropolitan area, and rail connections to
Coimbatore and Erode. The city became a major centre for the manufacture of cotton-
knit textiles late in the 20th century.

The resident bleaching and dyeing units cause pollution to environment by
inadequate treatment of their effluents. About 700 bleaching/dyeing units are located
which mainly process cotton knitted material. All these units contribute about 100,000
m$^3$ of wastewater per day. In former times, this high volume has been discharged to
the Noyyal River, without any treatment. The textile processing industry (TPI) in
Tirupur contaminates the river Noyyal and the groundwater, not only with unfixed
dyes but also with high amounts of inorganic salts and different other additives.
Textile wastes are generally coloured, alkaline, high in TDS and SS as well as
temperature. The contamination of water bodies and groundwater with Total dissolved
Solids (TDS) is rendering the water unfit for drinking and industrial purposes. Tirupur is
situated in a semi-arid region showing a negative water balance, e.g. the inorganic
material remains in the soil and leads to degradation of land.

1.1 SCOPE OF THE STUDY

The scope of the study is to investigate the options of pollution prevention
and control considering an integrated approach.

(i) Waste stream segregation
    Separate high load low volume from low load high volume
    Treat concentrated dye bath separately
(ii) **Biological treatment**
Avoid the consumption of chemicals (flocculants)
Reduce treatment costs by introducing biological method
Eliminate the production of hazardous sludge

(iii) **Membrane Technology with reject management**
Explore Pre-treatment options (Filter Sheets, Cartridges, MF)
Recover / recycle process water from washing and rinsing waters
Investigate Colour, COD/TOC removal (NF/RO)
Reject (brine) concentration and electrolysis

(iv) **Advanced oxidation processes**
Avoid the use of chemicals like NaOCl due to the TDS and AOX problem
Introduce cost effective decolourisation methods

The study started with the investigation of processes in the textile finishing process, reactive dyes, additives and chemicals, which are commonly used. Based on the results one precondition was assumed to be essential for the success of any advanced approach of the problem: viz. the concentrated dye bath and lower concentrated rinsing baths have to be segregated.

Considering this as a precondition the research took place in areas/fields, which were not investigated earlier. Because biological treatment steps are very economic the biological treatment of segregated effluent from exhausted dye baths was investigated. The biological treatment of mixed wastewaters containing low salt concentrations was proved by different authors (Geis 1992), (Braun et al 1997), (Heinfling 1997), (Hemmi 1997), (Blümel 1997), (Sosath 1997), (Libra 1997). Biological treatment of concentrated dye bath involving screened halophile microorganisms found locally for either aerobic or anaerobic conditions was explored.
In the textile research group at the Centre for Environmental Studies different advanced oxidation processes (AOP) were already investigated (Ozone, Photo catalysis using TiO₂ or red mud, Solar Photo catalysis). One area was identified which was not investigated so far: The application of vacuum-UV-induced photo-oxidation with a xenon-excimer lamp for concentrated dye-baths and combination with H₂O₂ dosage. Vacuum-UV (VUV) (and H₂O₂) oxidation represents an advanced generation of photo-oxidative wastewater treatment processes.

For the solution of the burning Total Dissolved Solids (TDS), membrane technology was investigated, which is already playing a major role in the field of water recovery in many other industrial branches. The experiments conducted support the process of finding integrated solutions for the treatment of textile effluents exploring reuse and recycling options.

1.2 OBJECTIVES OF THE STUDY

(A) Assessment of the present industrial status and state of the art
(B) State of the art / GAP Analysis
(C) Consider Cleaner production measures and evaluate their potential
(D) Characterize segregated waste streams
(E) Study the treatability of the segregated waste stream considering point A Halophile aerobic treatment
   Halophile anaerobic treatment
(F) Combined treatment in the form of an RZTP
(G) Application of membrane technology
   Pre-treatment (MF)
   Colour / TOC removal (NF/RO)
   Brine recovery / water recycling (NF/RO)
(H) Study reject management options / explore brine utilisation
(I) Evaluate Hypochlorite production (Electrolysis)
(J) Evaluate economic feasibility and discuss options