INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	**Ph.D.**
Thesis Title:		**Treatment of Blast Furnace Wastewater and Utilization of LD Slag from Steel Industry**
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SHORT ABSTRACT

Steel industries are one among the major industries which contribute to the world's economic growth. However, waste generation within the industry is enormous due to its high production rates. Large quantity of water is used in the steel industry for different processes like cooling operations, dust scrubbing and descaling. Nanofiltration (NF) is been used as a tertiary treatment system for the blast furnace (BF) wastewater in TATA Steel Ltd., India. The volume of the reject stream varies between 20-30 % of feed steam. This membrane reject stream contain concentrated monovalent and divalent ions (3- 4 times of feed). Available technologies for the treatment of NF reject are not efficient and economically viable due to high energy and space requirement (eg. Solar concentrator). Therefore, there is an urge for a more efficient, economical and facile technique for the treatment of membrane reject stream. Similarly, around 2 – 4 tonnes of waste

per tonne of steel are being generated within the industry. Linz Donawitz (LD) slag is or the wastes in integrated steel industry. Globally, production of LD Slag is around 47 MT per annum. Hence there is a need for use of the LD slag in much persuading way through either conversion of slag into useful material or recycling as process material. Taking all these issues into considerations, the main objectives of this work are divided into two sections. First section deals with the treatment of highly saline wastewater from blast furnace unit of steel industry. And the second section deals with the utilization of LD slag which is a by-product of steel industry.

Firstly, the work is focused on the removal of chlorides and sulphates from nanofiltration rejected water which is generated in the blast furnace unit of steel industry by the method of precipitation using miscible organic solvents such as diisopropylamine (DIIPA), isopropylamine (IPA), and ethylamine (EA) in different proportions. Solvent based precipitation showed that miscible organic solvents such as DIPA/IPA/EA is effective in precipitating salts from NF rejected water and thereby reducing the concentrations of chlorides and sulphates. Effects of solvent to water ratio, pH, temperature and mixing time was thoroughly investigated and optimized using central composite design (CCD). However, due to the recalcitrant nature of brine, treating highly saline wastewater with only one treatment system is insufficient. The drawbacks of a single treatment can be resolved by using combined treatments, resulting in a more effective treatment process and improved outcomes. Therefore, the above mentioned work is extended with a novel concept of integration of closed-circuit reverse osmosis (CCRO) technology and solvent-based precipitation as a means of producing an exceptional quality of water by separating the salts especially chlorides and sulphates from highly saline nanofiltration (NF) rejected stream of the steel industry. The outcome of this work showed that the overall

removal efficiency of sulphate and chloride was found to be 99.88 % and 91 %, res
Preliminary treatment cost was estimated and found to be around 7.35 $/m^3. The tre
can either be recycled in the system or safely released into the environment.

Further, work is focused on utilizing the solid waste generated from steel industry for the fabrication of porous ceramic membrane from Linz Donawitz (LD) slag. Membranes were fabricated using uniaxial method sintered at three different temperatures like 650 °C, 850 °C and 950 °C. Porosity, pore size distribution, flexural strength, chemical stability was determined and pure water flux experiments were conducted to evaluate the efficiency of the prepared membranes. Considering the raw materials cost, the cost of the fabricated membranes was estimated in the range of 32.55 - 55.7 USD/m^2. This work gives a potential path to develop microfiltration ceramic membrane with, high porosity and great quality in terms of strength and chemical stability. The fabricated membranes were utilized in a hybrid technique (flocculation followed by microfiltration) for the treatment of cold roll mill (CRM) wastewater generated from steel industry. However, LD slag contain significant amounts of chromium and releasing them into the environment creates some environmental issues. Hence the removal of chromium from Linz Donawitz (LD) slag from the steel industry as a part of environmental quality improvement of the slag material for further use was carried out. Removal of chromium from LD slag is done by the process of roasting and leaching using potassium hydroxide and water respectively. The efficiency of the roasting process for Cr removal was increased by optimizing the mass ratio of potassium hydroxide to the slag, roasting temperature and time. At the optimum condition such as mass ratio = 0.25, temperature = 450 °C, roasting time = 3 h and slag particle size = < 25 μm. Approximately 96 % of chromium was removed from LD slag. In this work, the residual slag is used as an adsorbent for the treatment of Congo red polluted wastewater.