


An Indian-Australian research partnership

Project Title:	Investigations on valorisation of top gas in blast furnace iron making	
Project Number	IMURA0337	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. **Clean Energy**
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

In the basic oxygen steel manufacturing process, oxygen is converted to CO and CO₂, which exits in the top gas from the blast furnace. This gas still has a significant calorific value, but due to its low pressure and the large volume, it is generally flared and therefore no energy is recovered and generates a significant CO₂ emission.

JSW would like to evaluate different options for the valorisation of the top gas. These options could include:

1. Recycling of a CO enriched stream around the blast furnace (this is not thought to be economic)
2. Provision of a CO enriched stream as a refinery fuel gas
3. Production of a purified CO gas product for external sales
4. Use of a purified CO gas product within the steel works

5. Using the water gas shift reaction to produce hydrogen
6. Use of chemical looping to produce hydrogen

Process investigations would need to consider the most efficient means of dealing with a high volume low pressure gas. Energy which may need to be expended to compress the gas and purify it would need to be justified economically. If the gas was used purely as an energy source, then the energy expended would need to be much less than the energy contained in the gas. On the other hand, if the valorisation was the production of a chemical, then a full economic analysis is required to evaluate these options.

There is already much research in the area of gas separations involving N_2 , H_2 , CO and CO_2 , due to the interest in both pre and post-combustion capture of CO_2 . However, the particular gas composition (approximately 50vol% N_2 , 30vol%CO, 20vol% CO_2) and its low pressure places some additional constraints and the best process will likely be different to the CCS research. The following separation techniques are available for the removal of N_2 , CO_2 . Adsorption is suitable for the removal of both CO and CO_2 and is commonly used in the production of H_2 . By optimising the pressure swing process, it may also be able to fractionate the CO and CO_2 stream. CO_2 can be removed from N_2 , H_2 and CO by solvent absorption processes, which have the benefit of having a low pressure drop. Membrane systems are able to separate H_2 and different systems can be used for N_2 and CO_2 .

Project aims

Define the aims of the project

Conduct a techno-economic and environmental assessment of the most economic method of valorisation of the blast furnace top gas. The assessment would include the synthesis of different processes for enriching and purifying the gas to different degrees to meet one of six potential uses for the gas.

Expected outcomes

Highlight the expected outcomes of the project

Determination of the cost, value and environmental benefits of processing the Top Gas

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

This project will address Theme number 3 "clean energy" by evaluating the options to make use of the CO content of the Top Gas rather than converting this CO to CO_2 without obtaining any benefit.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

The student should be a graduate of Chemical Engineering (ideal) or Energy Engineering or Metallurgical Engineering.

The student should be competent in using mass and energy balance process simulation software such as Hysys or Aspen Plus.

The student should have a fundamental understanding of manufacturing process economics.