2009 Issue 2 July 2009

THE

CATALYSTOR

Newsletter of the IESL Chemical Engineering Sectional Committee

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2009 Issue 2

Coming Events

Half Day Seminar on "Industrial Steam Boilers Using Biomass as Fuel": August 2009

Public Lecture on "Process Control" by Eng. S A S Perera.

Public Lecture on "Healthcare waste management" by Premium Engineering

Chemical and Process Engineering in Sri Lanka

Eng. Professor Ajith de Alwis

Science Team Leader, Sri Lanka Institute of Nano Technology

Sri Lanka today is definitely different to what it was few months back and certainly what it was a year ago. There is a high degree of optimism in the air. Some have shown that it is possible to achieve the impossible! Now the onus is getting the entire economy into a strong position so that we do not have to balance the national accounts by blood and sweat of some lakhs of people working overseas. Now it is time to bring in science and technology.

Chemical and Process Engineering (CPE) should also chart a more proactive road map for the profession. We know that in Sri Lanka we have not been more effective due to many reasons. CPE is not an infrastructure related engineering field. We thrive on infrastructure to really make the economy count by significantly adding value to resources. Today we see much infrastructure being done. That is quite useful as it is providing us with the necessary platform to be active. However, the case for engaging CPE's will not happen unless Sri Lankan CPE makes a conscious effort stating its case forcefully. Hope that take place! …..

Another thought crossed my mind when I was reading the "The Mechanical Engineer " published by the ASME Singapore section on their write ups on Bioengineering. Where are our sectional publications? For a 640 sq. km community they are doing quite well and dynamically. At National University of Singapore the Bioengineering corridor is Mechanical Engineering driven and they have embraced the bio interface quite willingly. Now Chemical Engineering was the discipline that truly integrated all four sciences and with economics is considered the broadest engineering discipline. That shine is disappearing fast with emerging technologies like Nanotechnology which is all sciences in one, is getting the attention of everybody. Bioengineering need to come in Sri Lanka (Biomedical engineering is a subset of bioengineering) and CPE should seriously take a lead role in developing this professional pathway. We must break the Sri Lankan A/L tradition of maths for engineers and biology for medics ! This is not helping Sri Lanka much these days as the world has changed fast. Other engineering fields have strongly demonstrated their presence and competence in this area of Nanotechnology with exciting products and services. Eric Drexler certainly started the ball rolling in the engineering domain. Nanotechnology when it is moving into mass scale will have its fair share of Scaling Up (Remember this is the name of the book published by IChemE, UK as the history of our profession) issues and these are bound to be quite unique as nano scale phenomena is quite different. It is an interesting area to think about as products or services not being available for masses will not be considered as of much use to anybody. There are many interesting discoveries and products that await this scale up challenge ! It is time to scale up our thinking here in Sri Lanka and CPE's should rise up to the challenge……

Chem. Eng. Section News

Photo Gallery :

Chem. Night. 28-02-09

Kerawalapitiya CCPP Visit

Lecture on Fire, Flammability & Explosions—May 2009

BIOMASS ENERGY FROM WOOD GASIFICATION – THE ISSUES?

Eng. (Dr) Suren Wijeyekoon
Department of Chemical and Process Engineering
University of Moratuwa

Plant or animal based sources that either fix inorganic carbon from atmosphere through photosynthesis and or assimilate carbon by respiration are known as biomass. Common examples of biomass sources for fuel are fuel wood, agricultural residues such as paddy straw, paddy husk, bagasse, saw dust and animal wastes such as cow dung etc. Energy from biomass can be derived through processes such as combustion, aerobic fermentation, anaerobic fermentation, gasification and cofiring. Gasification is an old technology that has recently received renewed interest owing to the energy crisis. However, with the collapse of the oil prices in 2008/2009, the growth of this technology has reduced due to number of issues. This article proposes to highlight some of the issues in the local industry related to wood gasification and also provide some chemical engineering aspects of gasification for the benefit of the reader.

The wood gasifiers in Sri Lankan industry use glidiciria, cinnamon or ipil ipil as biomass. Matured wood stems are cut to a size of 4 – 6 inch length on site or supplied by contracted suppliers as fuel and are dried to a moisture percentage of less than 20% before feeding. The biomass is either collected from own plantations or supplied with a price linked to the diesel price. One liter of fuel oil is said to be replaced by 3.5 kg of biomass that cost around 4 – 10 Rs/kg. Small gasifiers are manually loaded with chain operated buckets where as larger gasifiers are mechanically fed with electrically operated grab cranes, carts and buckets via feeding hoppers. The vertical oriented down draft type units ensure that no fumes are released when the gasifier is opened for feeding. The major issues on fuel have been the large area required for storage, the high moisture content of fuel, high labour involvement for preparation of wood and manual feeding of the biomass.

The gasifier is a cone shaped vertical reactor that incorporates three distinct zones (Fig.1). The feeding hopper that leads to the narrow upper section is the heating zone where the biomass is held during intermittent feeding. In the combustion or oxidation zone the following reactions are anticipated with heat generation:

$$C + O_2 \leftrightarrow CO_2 \qquad -401.9 \text{ kJ/mol}$$

$$H + 1/2O_2 \leftrightarrow H_2O \qquad -241.1 \text{ kJ/mol}$$

In all types of gasifiers, the carbon dioxide (CO_2) and water vapour (H_2O) are converted (reduced) as much as possible to carbon monoxide, hydrogen and methane, which are the main combustible components of producer gas. The most important reactions that take place in the reduction zone of a gasifier between the different gaseous and solid reactants are given below. A minus sign indicates that heat is generated in the reaction, a positive sign that the reaction requires heat.

a) $C + CO_2 \leftrightarrow 2CO \qquad +164.9 \text{ kJ/kmol}$

b) $C + H_2O \leftrightarrow CO + H_2 \qquad +122.6 \text{ kJ/kmol}$

c) $CO_2 + H_2 \leftrightarrow CO + H_2O \qquad +42.3 \text{ kJ/kmol}$

d) $C + 2H_2 \leftrightarrow CH_4 \qquad 0$

e) $CO + 3H_2 \leftrightarrow CH_4 + H_2O \qquad -205.9 \text{ kJ/kmol}$

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BIOMASS ENERGY FROM WOOD GASIFICATION – THE ISSUES?
Cntd.,

Equations (a) and (b), which are the main reactions of reduction, show that reduction requires heat. Therefore the gas temperature will decrease during reduction. Reaction (c) describes the so-called water-gas equilibrium. For each temperature, in theory, the ratio between the product of the concentration of carbon monoxide (CO) and water vapour (H_2O) and the product of the concentrations of carbon dioxide (CO_2) and hydrogen (H_2) is fixed by the value of the water gas equilibrium constant (K_{WE}). In practice, the equilibrium composition of the gas will only be reached in cases where the reaction rate and the time for reaction are sufficient.

The reaction rate decreases with falling temperature. In the case of the water-gas equilibrium, the reaction rate becomes so low below 700°C that the equilibrium is said to be "frozen". The gas composition then remains unchanged. Values of K_{WE} for different temperatures are given in Table 1.

Table 1 Temperature dependence of the water-gas equilibrium constant.

Temperature (°C)	K_{WE}
600	0.38
700	0.62
800	0.92
900	1.27
1000	1.60

Maintenance of high temperatures above 800ºC has resulted in many material failures especially in air nozzles. Excessive suit buildup is common problem that require frequent maintenance. The disposal of tar, ash and water slurry needs to be managed although the quantities are small and the slurry could be cooled and recycled. The coke produced (estimated as 2% of feed) from wood gasification is removed by mechanical means via the conical bottom with water that is separated in a pit. The settled water is recycled to the gasifier and the coke is made use of as a fuel in other applications.

The gases generated need extensive cleaning before being sent to boilers, gas engines or dryers. Air pollution control unit operations employed elsewhere are used here. Wide bodied and narrow bodied cyclones are used for particle removal and water scrubbers are used for fine particle separation that also cool the gases. Saw dust filters are used to absorb moisture and bag filters to further trap particles before feeding the gas to boilers equipped with dual fuel burners, internal combustion engines coupled to alternators for either thermal energy production or electricity production respectively.

These unit operations require frequent maintenance to up keep the systems trouble free. Many gasification plants have shut down with the falling of oil prices. However, financial calculations that compare only fuel prices do not adequately take into consideration of other tangible and intangible benefits of using biomass as an alternative energy source. Apart from being a GHG neutral fuel, gasifiers produce clean emissions, help save foreign exchange on fossil fuels, provides additional markets for fuel processing and employment that contribute to sustainable development.

Fig. 1 A gasification reactor

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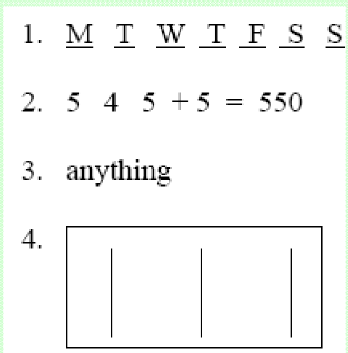
Answers to the last issue question



Most Commanding answer By

Eng. J A C Jayaweera

Other commanding submissions

1.K. G. H. Kodagoda

2.Eng. Dr. R. Shanthini

Information Reservoir (Ctd..)

PROCESS CHANGES, SAFETY PROTOCOLES & ACCIDENTS

By Dhammika Welhenge

1.Classification of Change

In our 2nd issue of *Catalystor 2007*, we discussed the importance of classifying changes made to a process plant. The two classes of change are:

1. Technology Change (Alterations which involve Change in Design)
2. Subtle Facility Change (Alterations which does not change the design)

It is necessary to ensure that all changes are made, strictly adhering to a change protocol, to safeguard people, property and environment, with an increased emphasis on following aspects:

2. Management of technology change

Any change to the documented technology e.g. changes in processed materials / ingredients, equipment design / layout / materials of construction, specified operating parameters / sequence, process design etc in a manufacturing / pilot plant, or setting up of an unfamiliar / non-routine experiment in an R&D laboratory, can potentially create new hazards.

Therefore any such change in approved or established documented technology or Standard Operating Procedure (SOP) invalidates or makes inadequate all prior hazard assessments.

The change may also invalidate earlier Statutory Licenses and approvals, and fresh approvals may be required.

The change therefore, needs to be scrutinised and managed well to safeguard people, property and environment, employing a suitable protocol or framework for management of Technology Change.

In this context introduction of a new technology in an existing or a new site shall also be considered as Technology Change.

3. Management of subtle facility change

Any change to the facilities within the documented technology of a manufacturing / pilot plant or within the standard operating procedures (SOP) in an R&D laboratory, but which is not replacement in kind is called a Subtle Change.

Some examples of what constitutes Subtle Changes are: minor re-routing of pipeline, relocation of a control valve on the same pipeline, installation of an additional pressure gauge (specified quality) on the pipeline, replacing a valve by one with better material of construction, re-routing of an electric wire, small improvements being done in factories.

Subtle Changes should not be confused with "Replacement in kind" i.e. a "like to like" change in a facility, replacing equipment or part with another equipment or part with identical specifications and supplied by the same vendor for maintenance / repair etc.

4. Combined Management of Change Protocol (MOC)

The MOC protocol should include the following steps. The sections marked in red are required only for the class of "Technology Change".

(a) Change Approval

The following considerations are addressed satisfactorily prior to undertaking any change:

- *Objective / technical basis for the change.*
- *Description of the change, clearly stating deviations from the documented*
- *technology/Lab SOP, and their implications in the context of Process Safety Information package (PSI)*
- *Preliminary Hazard Assessment Report (PHAR), and if necessary a more detailed HAZOPS*
- *Appropriate evaluation of risk and classification of change to identify authority schedule for progressing the change*

(b) Management of Change Brief

The brief shall consist of the above mentioned approved application sheets with all the attachments. In addition it will cover following elements:

- *Process and engineering design details corresponding to the change*
- *Revised SOPs, MSDS etc*
- *Occupational Health & Safety & Environmental care considerations*
- *Training needs*
- *Time limits and duration if change is temporary*

(c) Change Execution

Following steps would be implemented in the change execution:

- *Legal / statutory clearances on safety and environment.*
- *Hardware change*
- *Certification that the change is as per the MOC brief*
- *Pre startup safety review (PSSR)*
- *Commissioning trials.*