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Radioactive Tracing of an Industrial Scale Continuous Pulp Digester

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Background of the study:
Indian paper industry is having an approximate share of 2.6% to the global paper production from ˜813 paper mills. The chemical pulping process is widely used to produce paper using different types of raw material such as wood, bagasse, agro residue (wheat straw, rice straw) etc. The raw material is directly fed to a pulp digester along with white liquor to produce pulp. The obtained pulp from the digester is being used to manufacture of various type of paper including writing paper, printing paper, packing paper, etc. The performance of the pulp digester is very crucial for product yield, product quality, overall operating cost and waste generation. Hence, it is important to understand the flow behavior/ hydrodynamics of the pulp digester to optimize operating variables.

Methodology:
The industrial scale experiments were conducted for radioactive tracing of three tube continuous pulp digester in Satia Industries (India) using radioisotopes Br-82 and Au-198. The tube length and diameter of single tube of pulp digester is 12m and 1.45 m respectively. Wheat straw and white liquor were fed to the digester at 157–169 ℃ temperature and 5.39–6.45 kg/cm2 pressure. The white liquor was fed at the rate of 360 liter per minute and wheat straw was fed at feeder screw speed of 65 rpm. The radiotracer was injected at the inlet of the pulp digester using high pressure pump. The four radiation detectors were used to record the radiotracer concentration at the inlet and outlet of each individual digester tubes. The recorded radioactive signals were compared and used to elucidate the residence time distribution, mean residence time (MRT) and flow behavior of pulp digester.

Results:
Approximate ˜20% difference were found in MRTs of Au-198 and Br-82. The higher value of MRTs for Au-198 than Br-82 indicating some adsorption of Au-198 on wheat straw. MRTS for Au-198 is representing MRTs of bulk flow (pulp), whereas MRTs using Br-82 represent MRTs of liquid phase only. The segregated, erratic and inhomogeneous flow were observed in first digester tube. The axial dispersion model with plug flow component in series were found suitable for both cases. The non-dimensional axial dispersion coefficient for third digester tube were found as 270 and 250 for Au-198 and Br-82, respectively.

Conclusion:
The present radiotracer technique is found well suited for tracing of the pulp digester even at high temperature and pressure to identify the malfunctioning such as back-mixing, reverse flow, bypassing and stagnation volume of pulp digester, etc. This technique can be used for locating the leakage, fouling or other abnormalities.

Keywords:
Pulp digester, Radiotracer, Bromine-82, Gold-198, Residence time distribution, Mean residence time.

Country/Organization invited to participate

India

Primary author: Ms SHEORAN, Meenakshi (Department of Chemical Engineering, Thapar University, Patiala 147004, Punjab, India)

Co-authors: Mr CHANDRA, Avinash (Department of Chemical Engineering, Thapar University, Patiala 147004, Punjab, India); Mr BHUNIA, Haripada (Department of Chemical Engineering, Thapar University, Patiala 147004, Punjab, India); Mr PANT, Harish J. (Isotope Production and Applications Division, Bhabha Atomic Research Centre, Mumbai 400085, India); Ms BISWAL, Jayashree (Isotope Production and Applications Division, Bhabha Atomic Research Centre, Mumbai 400085, India); Mr BAJPAI, Pramod K. (Department of Chemical Engineering, Thapar University, Patiala 147004, Punjab, India); Mr RAO, S.Madhukar (Satia Industries Limited, Sri Muktsar Sahib 152101, Punjab, India)

Presenter: Mr CHANDRA, Avinash (Department of Chemical Engineering, Thapar University, Patiala 147004, Punjab, India)

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