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Conveying air requirements for a dense phase fly ash pneumatic conveying system

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ABSTRACT

An investigation was undertaken into the air usage for a dense-phase pneumatic conveying system that removes fly ash from coal-fired power station generating 800 MW each per each Unit. The objective of the research was to establish the air flowrate required to convey fly ash in dense phase and also determine if the installed compressors will be sufficient to supply the required air flow and pressure. Based on the experimental findings, theoretical models were to be developed that could be used to predict performance of similar systems operating in dense-phase. Three Units in commercial operation (out of six eventually) were used as test facilities for the research with conveying distances of 402 m, 516 m and 628 m respectively for Units 1, 2 and 3. The conveying pipelines used in the research all had a pipe diameter of 265 mm. All the equipment and facilities had been installed prior to the research. Tests were conducted to determine the air flow rate, solids flow rate and pressure drop during conveying cycles for the three Units. These tests were performed as part of normal plant operations without any modifications. Of the three Units, Unit 2 displayed results close to predictions for a dense phase system with an air flow rate of 1.86 kg/s and solids loading ratios averaging 19. Unit 1 and Unit 3 results indicated the need for further optimization with average air flow rates and solids loading ratios of 2.8 kg/s and 10 respectively. The pneumatic conveying characteristics observed during the experimentation allowed for estimation of the solids friction factors for the horizontal conveying sections using the back-calculation method. This experimental friction factors were then compared with expected results from literature-proposed models such as the Jones and Williams (2003) and Behera *et al* (2015) models. These models gave over predictions when compared with the experimental results, with the Jones and Williams' model predicting values averaging 72% higher than expected, and the Behera model with an average 60% over prediction across all Units. Applying the same approach as adopted by Behera *et al* to develop their model and using the experimental results from this research; new models were developed for predicting the solids friction factors for each of the Unit under investigation. Although these new models provided better estimation when compared with the Jones and Williams and the Behera *et al* models, they were also prone to over prediction. The model developed from Unit 3 results proved to be the best Equation from all the models considered with an overall over prediction of 48% across all Units. This model was also used to estimate performance of the last Unit and predicted a conveying pressure drop of 270 kPa which is realistic considering the performance of Units 1, 2 and 3. As such, although there are ranges of models available in literature that are useful to estimate the conveying pressure drop, these must be applied with considerable caution if experimental performance data are not available. The research

revealed that plant modifications are necessary to improve the current performance for Unit 1 and Unit 3. These modifications will also assist in verifying available models used to predict solids friction factors inclusive of the models proposed in this research.