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Detailed Design and Construction Approach for 3000 ton/day CO_2 Capture, Dehydration, and Compression Facility Based on Coal Flue Gas and HTC/DPS Technology

Ahmed Aboudheir[a]*, Scott Hume[b]

[a]*HTC Purenergy, 150 – 10 Research Drive, Regina, SK, S4S 7J7, Canada*
[b]*Doosan Power Systems, Porterfield Road, Renfrew, PA4 8DJ, United Kingdom*

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1. Introduction

A Front-End Engineering and Design (FEED) study was developed to consider the retrofit of a Post-Combustion Carbon Capture (PCCC) Plant sized to capture 3,000 tons of CO_2 per day from Unit 1 at Basin Electric Power Cooperative's Antelope Valley Station (AVS) in Beulah, North Dakota, USA. AVS is a lignite-based, mine-mouth facility with two 450MWe sub-critical boilers. AVS is located adjacent to the Great Plains Synfuels Plant, owned by a Basin Electric subsidiary -- Dakota Gasification Company (DGC). The Synfuels Plants is also a lignite coal, mine mouth facility and, through a gasification process, converts this low rank fuel into a pipeline quality, synthetic natural gas. The FEED study includes CO_2 capture unit, dehydration unit, and compression unit to treat a slip-stream of the flue gases produced from Unit No. 1 at AVS. . Formulated solvent was utilized in this chemical absorption process to achieve CO_2 recovery targets of 90% and on-stream factor of 90%. The captured and conditioned CO_2, with more than 99 mol% purity, was compressed to 185 barg and sent out at the boundary limit for enhanced oil recovery applications. The main design and cost data of the FEED study for the CO_2 capture, dehydration, and compression units have been highlighted in this paper. The study provides a feasible engineering design and acceptable production cost taking into consideration all the technical, economic, and plant location factors.

2. Design Approach

The FEED Study was developed as a collaborative effort, with the Project Team comprised of members from DPS, HTC, Basin Electric, Dakota Gasification Company and Burns & McDonnell (Basin Electric's Owners Engineer). The selected process flow sheet to meet the required production capacity and the cleanup targets at minimum energy consumption is based on the use of the RS-2 Solvent and TKO proven/patented process configuration. The material and energy balances required to size the main equipment and to estimate the consumption figures are generated by rate based model, which has the capability to predict accurately the

performance data of the Boundary Dam Pilot Plant, ERTF Pilot plant, and commercial amine plants. All the design parameters have been obtained from actual pilot plant data using the similar configuration and solvent, as well as vendors' inputs. The scale-up issues have been addressed using pilot plant approach in this work.

3. Capital and Operating Costs Approach:

From the final PCCC plant design, the Project Team developed a ±15% estimate of the Capital Cost, based upon a turnkey Engineer, Procurement, Construction (EPC) scope of supply. As the EPC lead, the Project Team utilized Doosan Engineering and Services (DE&S) – a US based engineering services firm - to provide detailed engineering support to the FEED. The Project Team with support from DE&S initiated a formal process to select a local construction partner to provide the Site Erection services. The EPC estimate was developed with support from DPS' Procurement Function, with vendor proposals for all purchased equipment, bulk materials and site erection. The estimate for the annual operating costs was developed, again, in close collaboration with the Client. The Project Team provided the estimated consumption of utilities and worked with vendors to develop a list of critical spares. The Doosan Project Team, the Client and Client's Engineer jointly developed an estimate for labor hours required to operate and maintain the plant. And, the Client provided costs plant operating and maintenance labor for Utilities and consumables from which the Project Team was able to develop the annual estimated operating and maintenance costs.

4. Construction, Commissioning, and Operating Approach:

As part of the FEED study, the Project Team developed a Project Execution Plan that included details on the Site Construction and Commissioning. The Project Team also developed a Plant Controls Operating Philosophy, which was included as part of the final FEED Deliverables. The proposal for site erection was based upon a collaborative effort with the shortlisted, erection sub-contractors and included constructability reviews. This was done to ensure that EPC Project Schedule and Cost Estimate were aligned with the Project Execution Plan.

5. Key Findings

The FEED Study was completed in November 2010. The paper will discuss some of the key findings that resulted from the FEED Study. The paper will also summarize some of the key deliverables of the FEED, including the EPC Project Schedule, EPC Capital and Operating Cost Estimates and selected Engineering Studies that were developed in support of the FEED.