SaskPower Boundary Dam project

SaskPower is leading the development of one of the world's first and largest carbon capture and sequestration demonstration projects at the Boundary Dam Power Station in Estevan, Saskatchewan, Canada, and has awarded SNC-Lavalin an Engineer, Procure, and Construct (EPC) contract to build this CO2 capture system with Cansolv Technologies Inc. providing the process technology.

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SNC-Lavalin together with Cansolv will assist in commissioning and startup of the plant, pending SaskPower's final decision scheduled for before the end of 2010 as to whether or not to proceed with the full execution of the project.

The project will be fed by flue gasses from an existing 150MW lignite coal-fired unit that is being retrofitted for carbon capture, and will supply CO2 for enhanced oil recovery (EOR). Successful operation of this carbon capture technology may lead to the retrofit of the other units at the Boundary Dam Power Station, and aid in the commercialization of this technology.

This article provides an overview of the project and a brief summary of the development from concept to implementation, as well as some of the techniques being used by SNC-Lavalin in its implementation.

Based in Canada with operations worldwide, SNC-Lavalin is one of the leading engineering and construction groups in the world with a long track record delivering projects in sectors such as power, oil & gas, infrastructure & environment, and mining & metals.

With over 20,000 staff located worldwide, SNC-Lavalin is currently working on projects in over 100 countries. A unique exposure to both the power and oil & gas sectors places SNC-Lavalin in a unique position to design and execute CO2 capture projects. As a result of being awarded a competitive Front-End-Engineering Design contract in 2009, SNC-Lavalin's EPC proposal for the complete EPC of the facility was selected ahead of 2 other competitors, and accepted in early 2010 with anticipated project completion by the end of 2013.

Figure 1: CAD Overlay of Future Carbon Capture Plant

Technology provider Cansolv Technologies Inc. (CTI) are a wholly-owned subsidiary of Shell Global Solutions, and are providing the core SO2/CO2 removal technology for this project. Pioneers of the use of regenerable amines for selective bulk scrubbing of SO2 from oxidative flue gases, Cansolv brings a unique approach to the challenge of CO2 capture with their integrated SO2/CO2 technology offering.

SaskPower is the electrical utility for the Province of Saskatchewan located in central Canada. Its power generation portfolio includes three coal-fired power stations, seven hydroelectric stations, five natural gas stations and two wind facilities.

Project background

Carbon capture and sequestration technology in a modern power plant has the potential to reduce the carbon dioxide emissions to the atmosphere by approximately 90 percent. For this project, the resulting captured CO2 emissions will be compressed and transported through pipelines and sold for Enhanced Oil Recovery (EOR).

When completed, the SaskPower integrated carbon capture plant will capture over one million tones of CO2 per year, reflecting a 90% CO2 capture rate for the 150MW coal-fired unit. Additional benefits of the project include integration of an SO2 capture process that will provide feedstock for a 50 ton per day sulfuric acid plant. The project scope also includes the EPC of an acid plant, where SNC-Lavalin is a worldwide leader in sulfuric acid plant design.

The Boundary Dam Power Station is an aging asset in the SaskPower fleet, and the intent is to extend its life rather than replace the plant. The current projection is that the planned upgrades to the plant will extend its useful power production life by 30 years.

As part of this plant retrofit effort, a requirement to perform a Steam Turbine Generator replacement is imminent; by integrating the overall retrofit requirements with CO2 and SO2 capture implementation, savings will emerge versus an uncoordinated approach that would require significant rework of completed installations if carbon and sulfur capture were implemented separately.

Cansolv Integrated SO2 / CO2 Capture Technology – A Brief

Since SaskPower's Boundary Dam Station Unit 3 had no existing SO2 treatment, to retrofit the unit to capture carbon dioxide first required the addition of flue gas desulfurization (FGD) technology. In offering a single integrated system utilizing technologies that are very similar, Cansolv is uniquely able to integrate the SO2 and CO2 systems that work in unison within a single plant.

The Cansolv process incorporates FGD into the "front-end" of the treatment process, and maximizes efficiencies in alignment with SaskPower interests in maximizing heat integration and minimizing Low Pressure steam usage. One such example is the recovery of waste heat from the SO2 process, which will be utilized in the capture of CO2, lowering the overall parasitic energy load that is associated with typical amine-based carbon capture processes. The second form of internal heat integration is internal to the CO2 system itself.

The result is a single system that delivers two marketable by-products where captured SO2 is converted into sulfuric acid (H2SO4), and captured CO2 is compressed and used for Enhanced Oil Recovery. This contrasts with alternative FGD technologies such as wet limestone scrubbing, which produce a contaminated waste by-product that would add additional operating costs to the project.

At the heart of the Cansolv process are the patented Cansolv solvents: DS (SO2 scrubbing) and DC-103™ (CO2 capture). Each offers distinct advantages, including:

- Low regeneration energy;
- Low solvent degradation Fast kinetics: similar to primary amines;
- >99.9% SO2 and CO2 product purity;
- Produces Minimal effluent;
- Guaranteed removal efficiencies.

As a matter of sequence, flue gas is first sent to the SO2 absorber and then onto the CO2 absorber before being returned to the stack with zero SO2 and only 10% of the CO2 remaining. The gas is first quenched and sub-cooled in a Prescrubber section, which is located in the SO2 absorber. SO2 and CO2 are absorbed from the gas by contact with the Cansolv solvents through sections of structured mass transfer packing in the absorption towers. Lean cool amine is fed to the top of each Absorber Tower.

In each tower, as the absorbents flow down the column counter current to the feed gas, the pollutant is absorbed into the amine. The rich amine collects in the sump of the Absorber Tower and is pumped to the Regeneration Tower (or "Stripper"). Since the absorption of CO2 is an exothermic reaction, interstage cooling is employed mid-tower to remove this heat from the Absorber tower, thus maintaining efficiency.

The rich absorbent is pumped at a constant rate to the Regeneration Tower through a Lean/Rich Heat Exchanger that recovers sensible heat from the lean amine. A Reboiler is used to generate stripping steam which is injected into the bottom of the column. As the liquid solution flows down the tower, it meets the rising hot steam in sections of mass transfer packing where the heat reverses the absorption reaction and returns the SO2 and CO2 to the gas phase.

The gaseous product is carried overhead and cooled in the respective Stripper Condensers where most of the steam condenses. Water-saturated product (vapor) and product-saturated condensate are separated in the Stripper Overhead Accumulator and the condensate is returned to the top of the Stripper Tower as reflux. The CO22 product leaves the Stripper Overhead Accumulator and is delivered at positive pressure to the final dehydration and compression stage.

Engineering, Procurement, and Construction Challenges

With the core aspects of the novel carbon capture technology not yet fully defined to a commercial scale, SNC-Lavalin has met design challenges through innovative approaches. The size of the CO2 absorber to be utilized as part of the facility is on a scale that has not been implemented previously, but working with leading vendors, flow modeling and 3D reviews of the design have been successful in addressing unknowns and providing confidence to SaskPower and the project team who are now involved in engineering and procurement phases of the project.

Other scaling and technical challenges have benefited from implementing a full 3D CADD project execution using the advanced SmartPlant platform from Intergraph. By integrating Piping and Instrumentation Diagrams (as well as all multi-disciplinary engineering work) directly to the 3D model, end-to-end management of design through front-

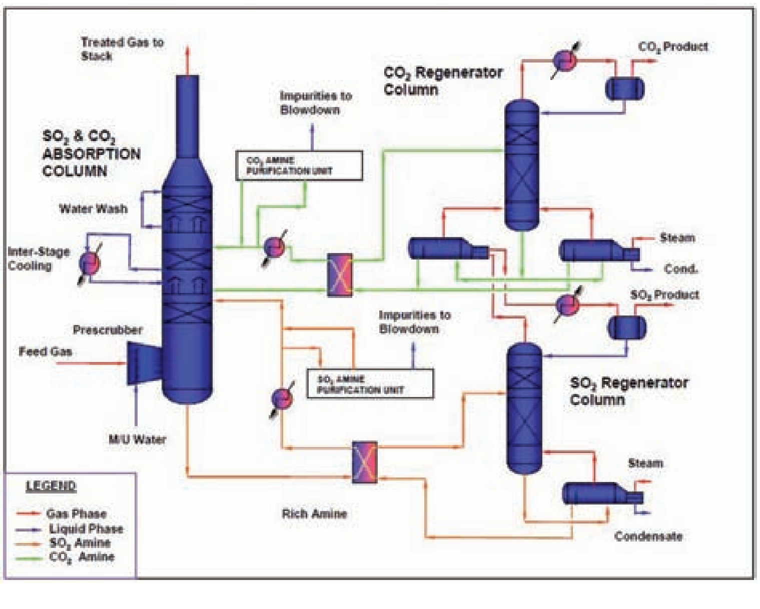

Figure 2: Flowsheet for Integrated Cansolv SO2/CO2 Process

Figure 3: 3D Model of SaskPower Carbon Capture Plant

end and detailed engineering has been maintained.

The benefits of this are reduced rework during construction where any field changes dramatically increase costs, and cause schedules to slip. Specifically, accurate identification of bulk materials and identification of potential clashes for routings of piping, equipment, and wiring are readily apparent during model reviews during the engineering phase of the project, where changes can be made when necessary with minimal impact.

Bulk materials which are identified and quantified via SmartPlant are downloaded electronically via a proprietary system developed by SNC-Lavalin called EMDS, directly into SNC-Lavalin's in-house project management system, PM+. The systems being utilized on the project have the positive effect of optimizing effort hours of engineering so that efficient use of available resources can be made.

Other aspects of the project execution where SaskPower is seeing benefits as a client is in attending and providing input into 30%, 60%, and 90% engineering completion model reviews. These reviews are managed by SNC-Lavalin with the technology provider and the client in attendance. Specific input is sought from SaskPower operations personnel as portions of the plant are viewed, with the intent that potential operations and maintenance issues are addressed immediately by the project team.

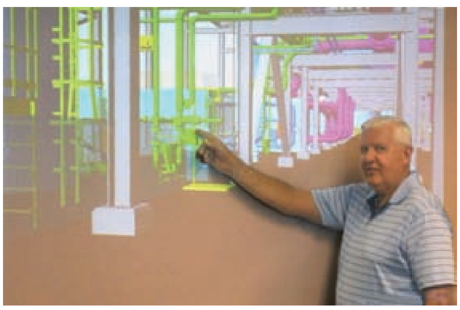

Figure 4: Project Director Walt Tomkiewicz walks through the 3D model during the 30% model review

These interactions are actively encouraged as part of SNC-Lavalin's design process that facilitates open communication with the client, resulting in positive changes being implemented across the entire model of the facility, leading to a design that SaskPower can be comfortable with. Similarly, the 3D model is also extremely helpful in Hazard and Operability (HAZOP) reviews of the plant where client personnel can see and fully appreciate the implications of control systems, and potential implications of hazardous situations that could arise, and implement the appropriate design changes to mitigate risks to future operators, and the plant itself. The SmartPlant 3D model may also be used for operator training prior to startup.

A great focus has also been placed on design for constructability throughout detailed engineering. The Saskatchewan construction and labor market is constrained, with the regional weather (notoriously harsh Prairie Winters) also reducing the calendar year that is suitable for construction. Areas where field construction can be optimized have been exploited to provide the project with potential schedule advantages.

Modularization of areas of the plant where possible has been emphasized, while accommodating restrictions imposed in transporting large modules and equipment to the landlocked location within the Central Canadian Province. Specific attention has been paid to modularizing utility racks, which will be shipped to the project site directly and interconnected in the field reducing rework, but requiring incredible precision and detail in the detailed engineering phase.

Sequencing of construction given the size and scope of equipment and modularized portions is also a big part of design efforts underway, with construction looming in early 2011.

SaskPower Competitive FEED Execution Model

In awarding the project, SaskPower benefited from first implementing a competitive Front-End Engineering Design (FEED) stage where three competing technology/EPC contractor teams were selected and awarded a mandate to develop a full FEED package, and EPC proposal to design and build a carbon capture facility.

With proven commercial scale CO2 solutions not available in the marketplace currently, this approach allowed competitors to undertake the necessary engineering to develop designs to a level to finalize costs for major equipment, piping, materials and construction and avoid heaping large amounts of contingency on pricing making potential solutions uneconomic from the outset, and ensuring that the aspect of competition would also encourage creativity and efficiency in the designs and EPC proposals provided.

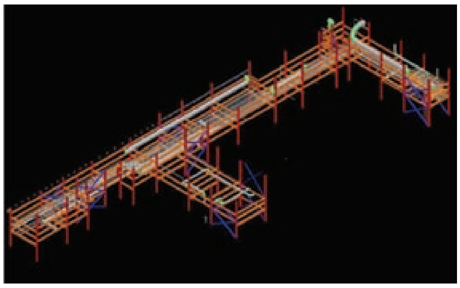

Figure 5: 3D Model of Modularized Utility Rack

SaskPower's execution strategy has also reflected the reality of a project involving a novel scale-up of technology As with all similar projects that involve scaling up technologies, risks associated with warranties on the processes involved, and performance guarantees for the plant are hot button issues.

Risk allocation between a client, the technology vendor, and the EPC firm needs to be appropriately divided to help novel projects like this to move forward. SaskPower included time in its execution schedule to ensure that this significant contract negotiation issue was given sufficient focus without risking overall project schedule. For all such projects, this element should not be overlooked.

In summary, through the application of Cansolv's state of the art carbon capture technology and SNC-Lavalin's depth of expertise and advanced execution tools, all elements are in place to successfully implement one of the world's first and largest carbon capture facilities on behalf of SaskPower, and further the commercialization of this technology.

More information

For further information relating to this project, or related subjects, please contact:

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