Design Concept for 40,000 m^3 Floating CO_2 Liquefaction, Storage and Offloading Unit Including Shipping (CO_2 FLSO)*

Due to global warming resulting from CO_2 emissions, there is strong political pressure for any combustion process to reduce the emission of greenhouse gases into the atmosphere. Power plant operators in particular need to consider carbon capture and storage (CCS) schemes in order to comply with future regulations. There are three options available in CO_2 sequestration processing. In each one CO_2 is captured, compressed and dried at the power plant. After these steps, there are two options for avoiding the release of CO_2 into the atmosphere:

Option 1:
Pressurising CO_2 by means of pipeline compressors at ambient temperature to very high pressures (80 to 150 bar) and pumping CO_2 through pipelines either to an onshore underground storage cavern or offshore to a depleted oil/gas field.

Option 2:
Pressurising CO_2 to a medium pressure of approx. 20 bar at the power plant, liquefying CO_2 by means of standard refrigeration and storing liquid CO_2 in a buffer tank system before shipping the cargo in special CO_2 carriers to depleted oil/gas fields.

Both alternatives require technically sound and economical solutions in order to implement the necessary technology for storage, processing and offloading. TGE Marine Gas Engineering has developed a special modular barge system for the second option which can serve as a liquefaction, buffer storage and offloading terminal.
The terminal can also operate as a hub for several clients. CO_2 is conveyed in a small pipeline at approx. 20 bar to a storage barge. Buffer capacities from 10,000 m^3 up to 100,000 m^3 are technically feasible depending on project-specific parameters, in particular the distance to the depleted oil/gas field and the annual throughput capacity required.

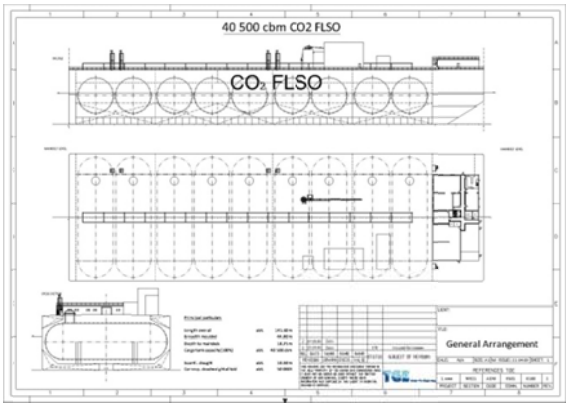
Based on its vast experience with IMO type C cargo tanks (i.e. pressure vessels) for ethylene and LPG carriers, TGE Marine Gas Engineering has upgraded its in-house design to meet storage, liquefaction and shipping requirements for the CO_2 transport chain. In collaboration with German steel mills, special high-strength steels for low temperature applications down to -40 °C have been investigated. In order to save energy

CO_2 Shipping

during the liquefaction process and to minimise loss of CO_2 in the production chain, 18 bar has been selected as the optimum level of pressure for keeping energy consumption low while also making the manufacture of large pressure vessels technically feasible.

Tank sizes of up to 5,000 m^3 per unit with steel weights of approx. 720 metric tons each were developed as basic modules for the CO_2-FLSO. These tanks can be fabricated at workshops outside the shipyard selected for hull and top side fabrication for the FLSO, reducing overall construction time. The same tank design can be used for CO_2 carriers and total capacities of up to 40,000 m^3 or beyond are technically feasible.

TGE Marine Gas Engineering's modular CO_2 barge design can handle up to 2 mtpa of throughput. A generic design for a single-train FLSO-barge has the following key parameters:



Length o.a.: ..... 145.60 m
Breadth moulded: ..... 44.80 m
Depth: ..... 18.75 m
Draught: ..... approx. 10.6 m
Cargo tank capacity (100%): ..... 40,500 m^3
Barge net steel weight: ..... 10,900 t

Topside process designs have been developed for different capacities and projects:

Example for FLSO application:
Annual CO_2 throughput: ..... 1,000,000 t
Refrigeration capacity: (4 x 33%) 12,500 kW
Power consumption: ..... approx. 6,500 kW
Loading rate: ..... approx. 120 t/h
Unloading rate: ..... up to 2,000 m^3/h
OPEX/CAPEX est.: ..... approx. €11/t
Incl. power cost at €50/MWh and onshore power supply, 20-year depreciation

CO_2 shipping solution (1 mtpa):
Ship size: ..... 15,000 m^3
Speed: ..... 16 knots
Shipping distance: ..... 450 NM
Number of round trips per month: ..... approx. 6
Specific shipping cost: ..... approx. €10.5/t

*Patent pending

For further information, please e-mail to sales@tge-marine.com