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Definition of Requirements for Safe and Reliable CO_2 Transportation Network through an Integrated Laboratory, Computer Modelling and Full Scale Methodology

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ABSTRACT

A significant CO_2 reduction of emissions from fossil fuel utilization in large industrial emitters (mainly power generation, but also refineries, cement work and steel production plants) down to acceptable levels can be achieved through different options, such as:

- increasing the efficiency. As an example some new power plants in Germany managed to reduce the CO_2 emissions by 40%,
- moving to another fuel with less carbon content, or to biofuels which is a renewable source,
- through CCS Carbon Capture and Storage of CO_2.

The Carbon Capture Transportation and Sequestration (CCTS) solution appears to be one of the most promising technologies under investigation in several Joint Industrial Projects sponsored by Energy Companies.
The optimal set up of all this technology has to be found very timely. Energy penalties associated to each part of it (Capture, Transport and Underground Storage) should be carefully evaluated to launch promptly pilot projects with the aim to get know how and accumulate experience from "the in field exercise"; at the same time all the aspects related to safety and reliability of CCTS chain are of paramount importance for the industrial deployment of the technology in "full scale" applications.
The European Union Renewable Energy Directive and European Commission (2012), have in fact drawn the road map to cope with a 20% cut in greenhouse gas emissions by 2020.
As a matter of fact, in the latest years a lot of studies and funds have been devoted to reduce the energy penalty for the CO_2 capture at concentrated emitters as well as to evaluate the most proper monitoring systems for the storage sites, but no effort has been done to fill the gap in the transportation.

This paper is focused on the CO_2 transportation by pipeline, as this is the only way to gather large amount (order of magnitude of millions cubic meter per year) of Carbon Dioxide produced and separated from the other pollutants at the large emitters stacks. Pipelines can efficiently transport supercritical "pure" CO_2 (coming from natural reservoirs and largely used in North America for the Enhanced Oil Recovery since the late 70s), nonetheless some specific issues have to be investigated due to the nature of transported fluid, particularly when it comes from industrial plants and is richer in a large variety of impurities compared to "natural carbon dioxide". In particular the major challenges for these infrastructures can be summarized in the following key issues: engineering design of pipelines from the long term integrity point of view, adoption of proper codes/standards, public acceptance on safety issues. An integrated approach is necessary to get specific requirements to be used in design, material selection, corrosion and fracture avoidance, operation & maintenance of steel pipes for anthropogenic carbon dioxide transportation pipeline systems. This paper also underlines differences and analogies from natural gas transportation.

KEY WORDS: Anthropogenic CO_2, CCS; Carbon Capture, CO_2 pipeline, EOR.

NOMENCLATURE

ABL	:	Atmospheric Boundary Layer,
AC	:	Accelerated Cooling,
API	:	American Petroleum Institute,
CCS	:	Carbon Capture & Storage,
CFD	:	Computational Fluid Dynamics,
CSM	:	Centro Sviluppo Materiali,
DQ	:	Direct Quenching,
EC	:	European Community,
EOR	:	Enhanced Oil Recovery,
EPRG	:	European Pipeline Research Group,
EU	:	European Union,
GHG	:	Green House Gases,
HSLA	:	High Strength Low Alloy (steels),
IGCC	:	Integrated Gasification Combined Cycle,
LNG	:	Liquefied Natural Gas,
LPG	:	Liquefied Petroleum Gas,
NGCC	:	Natural Gas Combined Cycle,
O&G	:	Oil & Gas,
O&M	:	Operation and Maintenance,
PC	:	Pulverised Coal,
RES	:	Renewable Energy Sources,
SARCO2	:	Requirements for Safe and Reliable CO_2 Transportation Pipeline,
SCPC	:	Super Critical Pulverized Coal,
TMCP	:	Thermo Mechanical Controlled Processing.