

**Integrity of Pipeline Materials and Influence of Solvent
Impurities in Carbon Sequestration Network -
Injection and Storage**

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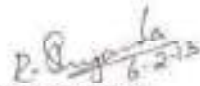
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CERTIFICATE

This is to certify that the thesis entitled "Integrity of Pipeline Materials and Influence of Solvent Impurities in Carbon Sequestration Network - Injection and Storage", submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for the award of the Degree of **Doctor of Philosophy in Chemistry**, is a record of original research work done by **Kanimozhi, K.R** during the period of her study in the Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship or similar title to any candidate of any other University or Institute.



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DECLARATION

I hereby declare that the matter embodied in the thesis entitled "Integrity of Pipeline Materials and Influence of Solvent Impurities in Carbon Sequestration Network - Injection and Storage", is the result of investigations carried out by me in the Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, under the supervision and guidance of Dr. Shyamala, R. Professor and Head, Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and it has not been submitted for the award of any Degree / Diploma / Associateship / Fellowship of any other University or Institute.



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An Overview of the Thesis :

The Industrial Revolution has not only changed the way people live, but also the behavior of the earth and the atmosphere that surrounds it. The climate change the planet experiencing in recent years is due to the escalating levels of carbon emissions coming predominantly from our continued use of fossil fuels. These anthropogenic activities may lead to disastrous consequences endangering the survival of life on the earth. It is now believed that anthropogenic CO₂ is the most significant green house gas (GHG) contributing to more than 50% to the global warming and climate change. The use of renewable energy sources though are on the increasing mode, the immediate energy demand is likely to be met only by conventional fossil fuel combustion. Therefore, in the light of increasing fears about climate change, **Carbon Capture and Storage (CCS)**, the subject of this research work) has assumed growing importance. At present it provides a bridging technology, since it allows a balance between increasing demands for energy and the requirements to reduce emission.

The basic idea behind CCS is to capture CO₂ from large industrial sources before it is released into the atmosphere, and then carefully transporting and storing it in matured oil and gas reservoirs or in other deep geological formations like saline aquifers where it would remain for thousands of years or longer. One of the major concerns in the capture and transport of CO₂ is corrosion. Dry CO₂ is inert to commonly used industrial materials. But CO₂ which is an acid gas will react with water to form carbonic acid which is corrosive. Carbonic acid corrosion of carbon steels has been known for years as a major source of damage in oil and gas pipelines referred to as "sweet gas corrosion". In addition to this there is a possibility for MEA and MEG (solvent) to get into the CO₂ transportation pipeline along with CO₂ as an impurity during the scrubbing processes. Moreover, during the injection of CO₂ into saline underground water turbulent flow conditions are formed creating conditions for **flow-induced localized corrosion (FILC)**.

Currently there is little knowledge on the effect of impurities on material properties under CCS operating conditions. Therefore, to select appropriate materials for CO₂ sequestration network, the corrosion behavior of materials in both super critical conditions as well as at atmospheric pressure flow conditions should be understood. With this back ground the present work is taken up to investigate the corrosion behavior of carbon steels (CS I, CS 5LX 42 and CS 5LX 60) and stainless steels (304SS and 316SS) in pure CO₂ environment as well as CO₂ containing solvent impurities like MEA and MEG under simulated flow condition and at atmospheric pressure by measuring mass loss using Rotating Cage (RC). Material composition of metals used in oil and gas pipelines has been reviewed for this work.

The corrosion behavior of the metals has been studied using fabricated rotating cage as per ASTM G 184 - 06 standards. It is a simple, compact methodology to simulate pipeline flow conditions in the laboratory to evaluate the corrosion rate of metals.

To ensure the reproducibility of the results from the rotating cage, the instrument was standardized using synthetic ocean water as per ASTM D 1141.

The results obtained from the present study has revealed that CS I performs better than CS 5LX42 and CS 5LX 60 in CO₂ environment. Also it is found that stainless steels (304 and 316 SS) shows better corrosion resistance in CO₂ environment than carbon steels. The surface morphology of the samples subjected to mass loss measurements were determined by Optical Microscopy and Scanning Electron Microscopy.

ABBREVIATIONS

GHG	: Green house gas
CCS	: Carbon Capture and Storage
MEA	: Monoethanolamine
MEG	: Monoethylene glycol
EOR	: Enhanced Oil Recovery
FILC	: Flow-induced localized corrosion
SEMEDS	: Scanning Electron Microscopy/ Energy Dispersive Spectroscopy
ASTM	: American Society for Testing Materials
Gt	: Giga tonnes
h	: Hour
mpy	: miles per year
PTFE	: Poly Tetra Fluoro Ethylene
RC	: Rotating Cage
CS	: Carbon steel
SS	: Stainless Steel
