DEVIN O’MALLEY
BEng (Chemical Engineering), Dalhousie University, 2011

DEPARTMENT OF PROCESS ENGINEERING AND APPLIED SCIENCE

TITLE OF THESIS:	INVESTIGATION OF UNDERSEA SOUR GAS WELL BLOWOUTS USING MULTIPHASE COMPUTATIONAL FLUID DYNAMICS
TIME/DATE:	11:00 am, Friday, March 16, 2018
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Pierre Proulx, Département de génie chimique et de génie biotechnologique, Faculté de génie, Université de Sherbrooke (External Examiner)

Dr. Dominic Groulx, Department of Mechanical Engineering, Dalhousie University (Reader)

Dr. Adam Donaldson, Department of Process Engineering and Applied Science, Dalhousie University (Reader)

Dr. Jan Haelssig, Department of Process Engineering and Applied Science, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Gianfranco Mazzanti, Department of Process Engineering and Applied Science, Dalhousie University
CHAIR:	Peter Duinker, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

The production of natural gas requires the removal of carbon dioxide and hydrogen sulfide during processing, resulting in a stream typically called acid gas. In offshore natural gas production, the disposal of these undesirable by-products is more challenging than during onshore production. One viable option is to reinject this acid gas into a depleted portion of the reservoir. This option effectively sequesters the waste stream and helps to maintain the production well pressure. However, the downside is that there is an increased need to transport and store this toxic gas, which increases the risk posed by a potential catastrophic failure and subsequent release of the gas. Although such a failure may be unlikely, the prediction of the resulting gas plume is the first step towards developing an emergency response plan.

During this work, a model was developed to predict the behaviour of a released acid gas stream in the water column following a shallow water release. The physical situation for such a release can be divided into three distinct regions: the momentum driven jet in the near field, the buoyancy driven plume region in the far field, and the free surface between the sea and the atmosphere. Only the first two zones were considered within this work. The developed multiscale computational fluid dynamics model constructed employed an interface capturing model for the near field, since the flow of gas was expected to be continuous. A mixture drift-flux model was used capture the behaviour of the far field as a plume of uniformly sized bubbles.

The development of each portion of the model is described in detail. An approach to facilitate direct numerical predictions of heat and mass transfer within incompressible and compressible interface capturing approaches was developed and tested. Then, the effect of computational mesh refinement on the ability of the interface capturing approach to resolve gas jet behaviour was studied. The multiscale modeling approach was then developed and tested through comparison to published small-scale experimental data. Finally, the model was used to simulate a realistic scenario involving the release of acid gas from a ruptured reinjection well.