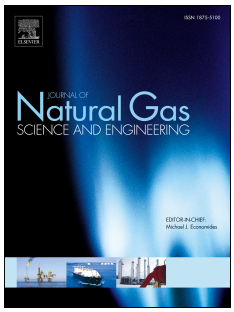
Accepted Manuscript



Determination of erosion-based maximum velocity limits in natural gas facilities

K.K. Botros, L. Jensen, S. Foo

PII: S1875-5100(18)30213-0

DOI: 10.1016/j.jngse.2018.05.013

Reference: JNGSE 2571

To appear in: *Journal of Natural Gas Science and Engineering*

Received Date: 27 February 2018

Revised Date: 23 April 2018

Accepted Date: 7 May 2018

Please cite this article as: Botros, K.K., Jensen, L., Foo, S., Determination of erosion-based maximum velocity limits in natural gas facilities, *Journal of Natural Gas Science & Engineering* (2018), doi: 10.1016/j.jngse.2018.05.013.

Determination of Erosion-based Maximum Velocity Limits in Natural Gas Facilities

K.K. Botros[1], **L. Jensen**[2], **S. Foo**[2]

[1] NOVA Centre for Applied Research, Calgary, Alberta, Canada (corresponding author: kamal.botros@novachem.com)

[2] TransCanada Pipelines Ltd., Calgary, Alberta, Canada

ABSTRACT

Erosion of pipe fittings is one of the top potential limiting factor for gas velocities in natural gas transmission systems. Objectionable materials such as black powder or any abrasive particulates, can be intermittently admitted to the natural gas transmission systems at receipt points, or formed in-situ along the pipeline. These solid particles impinge on pipe wall and fittings causing potential erosion integrity concerns especially at high velocities. The API RP-14E describes an approach to determine the maximum velocity limit to avoid erosion in offshore production facilities. While the application of this API RP is intended for offshore multiphase flows, it has been extended to natural gas transmission applications where gas is generally single phase with stringent pipeline quality gas specifications. In order to quantify the rate of erosion due to solid contaminants in gas streams, an experimental test program was undertaken. A test rig was constructed on a typical pipeline quality gas at pressure ranges between 4900-5400kPag, using DN200 (NPS 8) pipe. The gas flow passes through a converging nozzle of exit diameter = 38.1 mm intended to accelerate the gas to a much higher velocity of the order of 200m/s. The reason for such high gas velocity is to accelerate the rate of erosion and shorten the test duration. The high velocity jet stream impinges on a flat steel plate mounted at a 30^o angle close to the nozzle exit. Tests were conducted on two different sand particle sizes injected into the gas stream via a side port. The test results allowed tuning of parameters in semi-empirical erosion models, such as the velocity index and material constants, in an attempt to better quantify the erosion rates for a given concentration of solids in the gas stream. The paper describes the experimental setup, test procedure, results and analysis of erosion rates on ASTM A420 coupon material typically used in low temperature fittings in natural gas facilities.

NOMENCLATURE

C	Erosion velocity empirical coefficient, as per API 14E
B_h	Brinell hardness
DP	Differential back pressure on the sand canister
F_s	Solid particle shape factor
$f(\alpha)$	Impact angle-dependent erosion function
K	Material erosion constant
$MMSCF$	Million standard cubic feet
$\dot{m}_s$	Sand flow rate through the injection port