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## **SMRI Request for Proposal (RFP2023-06) “Maximum Hydrogen Velocities in Tubing Strings”**

### **1. Background**

This Request for Proposals (RFP) is issued based on questions within SMRI Research Committee about whether the general accepted assessment for maximum allowed velocities in tubing strings for fluids in the Oil & Gas Industry (e.g., API RP 14E) could be applied for Hydrogen operation too.

The API RP 14E guideline states that flowlines, production manifolds, headers and other lines transporting gas should be primarily sized based on flow velocity. And guideline recommends that when no other specific information as to erosive or corrosive properties of the fluid is available, the mixture velocity should be kept below the so-called “erosional velocity” obtained from the following empirical equation:  $V_e = c / \sqrt{\rho_m}$  where  $V_e$  is fluid erosional velocity,  $c$  is empirical constant and  $\rho_m$  is gas/liquid mixture density at flowing pressure and temperature.

For natural gas storage operations, a maximum allowable flow velocity of 100 ft/s (30 m/s) is commonly cited in several SMRI reports and papers, even though other figures are used depending on countries and companies.

As maximum allowed velocity and tubing sizing is an important parameter driving economics of hydrogen storage projects, this Request for Proposal is to verify the applicability of the maximum velocity in tubings and define the maximum velocity for different hydrogen storage situations. Such information will allow well designs to be optimized to maximize withdrawal rates and minimize tubing sizes.

### **2. Scope of Work**

The overall objective of the study is to provide a guideline for establishing maximum accepted velocities in tubing strings for hydrogen. The SMRI would like to understand the recommended velocities that can be permitted in tubing strings independent from the limitations associated with surface facility installations / adjacent pipelines.

The scope of work would be to:

- 1) evaluate the application of currently used guidelines – including review of current codes (API, ISO, Norsok) and identification of common methods / software packages used in determining tubing string velocity.
- 2) study different factors that influence velocities of hydrogen and provide comparison of these against natural gas.
- 3) determine the limitations of these factors – including consideration of well-known technical and operations limitations such as
  - Erosional velocity
  - Pulsation
  - Noise and vibrations
  - Fluid composition (presence of corrosive components)

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- Presence of solids
  - Configuration of completion/tubing/wellhead; what kind of restrictions are there e.g. bends, nipples, SSSV, tail pipe length etc.
  - Tubing material
  - Pressure and temperature
- 4) define the recommended method of determining maximum hydrogen velocities in tubing strings and present examples for representative well and flow scenarios which are likely to be commonly used on storage operations.

Deliverables:

The final report shall include the following:

- Review of state-of-the-art rules/guidelines for maximum natural gas velocities in natural gas caverns, and of Oil & Gas standards, and confirmation if these maximum velocity guidelines are applicable for hydrogen storage in salt caverns. If it is found that existing guidelines are not applicable for hydrogen storage in salt caverns, provide recommended modifications to the guidelines specified for hydrogen.
- Determine suitability of standard industry software packages to calculate hydrogen velocities in tubing and provide recommendations for software solutions to determine hydrogen velocities if they are not suitable.
- Assess impact that different parameters (such as saline environment or free salt particles) has on maximum velocities.
- Define the recommended method of determining maximum velocity of hydrogen in tubing string.
- Practical output for the design and operation of hydrogen caverns. For instance, it could be:
  - To confirm that the API RP 14E empirical equation of the “erosional velocity” stated in §1 can be used for hydrogen, using density as  $\rho_m$  and with recommendation for c (e.g., depending on the steel grade)
  - And/or a Matrix of maximum velocities taking into account at least the above-mentioned limiting factors within a pressure range of 0 – 300 bar and temperature range of -30 – 60 degrees Celsius. This matrix shall include at least tubing with material class for L80, N80 and other tubing which are at least hydrogen resistant.

Temperature range (-30 – 60 degree Celsius)	9 5/8” tubing L80 47# Velocity [m/s]			
	Erosion	Vibration	Sound	Pulsation
200 – 250 bar				
150 – 200 bar				
100 – 150 bar				
50 – 100 bar				
0 – 50 bar				

Table 1 example matrix L80 Tubing

- And/or other practical output to be proposed

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## 3. Proposal Instructions

Responses to this RFP should be reasonably brief (less than 10 pages), describe the proposed effort and offer a succinct discussion of the technical approach.

This RFP anticipates that a fixed-sum contract will be used, and a project schedule and cost plan will be submitted.

The qualifications and experience of the proposed researcher(s) in the technical field described within the Scope of Work are likely the most significant proposal-evaluation criteria.

Teaming and subcontracting to bolster qualifications are encouraged, but a strong lead researcher (project manager) must be identified in the proposal and will be named in the research contract as key personnel. The level of commitment of the lead researcher to the research effort must be itemized in the proposal.

Proposals should be submitted in electronic form via email to Tim Bauer, SMRI Research Coordinator, (tbauer@solutionmining.org), by 31 January 2024. Please email a statement of your interest or intentions to respond to this RFP before 29 December 2023, so you can receive any updates or modifications to this RFP. Questions relating to this RFP should be directed in writing (via email) to the Research Coordinator. Answers to questions that apply to all potential proposers will be forwarded to all identified proposers.

## 4. Contract Award and Contract Specifics

Proposals will be evaluated solely based on information contained in the proposal. The proposer selected for negotiation of a contract will be the one that best meets SMRI’s needs and is economically sound. SMRI has the right to select or reject any or all proposals.

The research contract will be negotiated between the selected contractor and SMRI. The contractor will be solely responsible for coordination of any subcontracted work and for all payments to any sub-contractor(s).

1. SMRI contract for this Work will be fixed sum for the defined statement of work. The proposed fixed-sum payment must be clearly defined in the proposal. Payment will be made upon acceptance by the Research Committee of the final research report. No other progress or interim payments would normally be made.
2. SMRI’s Project Sponsor will be named after contractor selection. The Project Sponsor will be the contact for any project-related communications.
3. The research project is to be completed within the time frame agreed on for the project.
4. The contractor shall present progress reports at each SMRI Research Committee meeting during the project and an oral research report at the end of the project. The costs for these presentations, if any, are to be included in the fixed-sum cost of the project. The Project Sponsor or Research Coordinator may present one of the two required progress reports per year to the Research Committee using materials (text and PowerPoint) prepared by the project team.
5. A final research report is required in the form of a standard scientific or technical report. The research report will provide standard information such as background and purpose for the research, theoretical basis and methods, data collected, analysis, references, and research conclusions. Depending on the amount of information used, either lists of information in appendices or separate electronic files of the information, or both, might be required. All report submittals (drafts-for-review and final) will be as electronic files, both MS-WORD (\*.doc) and PDF (\*.pdf). SMRI will supply

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formats/contents for its standardized report covers, title pages, and forward/disclaimer for its research reports. The research report will be reviewed by the Project Sponsor, the Research Coordinator, and the Research Committee. Before final report acceptance, the researchers must satisfactorily address all review comments.

6. The enclosed Standard Terms and Conditions for SMRI Research Contracts, dated 3 January 2023, shall apply. Additional limitations or modifications are possible before contract negotiation.
7. SMRI retains ownership and copyright of the work products resulting from this research. Limitations on publishing and release of information are listed in the Terms and Conditions.

Tim Bauer  
Research Coordinator

Enclosures:

Standard Terms and Conditions for SMRI Research Contracts, dated 3 January 2023

Cc: John Nadeau, Executive Director  
Andreas Reitze, 2023 SMRI President  
Daniel Noack, 2023 SMRI Research Chairman  
Members of the SMRI Research Committee

**ATTACHMENT  
STANDARD TERMS AND CONDITIONS**



**SOLUTION MINING  
RESEARCH INSTITUTE**

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Standard Terms and Conditions for SMRI Research Contracts **3 January 2023**

1. The contractor shall perform the scope of work and submit the contract deliverables specified in the Request for Proposals (RFP) and the contractor's proposal. If differences exist between the RFP and the contractor's proposal, the RFP shall govern, unless otherwise specified in the contract. All written or electronic communication regarding the research is to be in English.
2. The SMRI Project Sponsor(s) will provide technical oversight to include review of project plans, will assist in resolution of any technical issues which might impact the project or research results, will approve contractor progress reports, and will review all invoices for accuracy.
3. During the project, progress reports may be given by the contractor during Research Committee meetings generally on the Saturday before SMRI conferences begin, or the brief progress reports must be given to the Project Sponsor prior to the Research Committee meetings for informing the Committee.
4. After the first draft report is approved by SMRI's Research Committee, SMRI will provide a report number, a cover page, a disclaimer regarding the report contents, and a copyright notice which will become part of the final report. A filename and format will then be designated for the final report. All draft and final versions of the research report must include the date at the end of the filename
5. The final report shall be provided in electronic format in Adobe Acrobat word searchable (.pdf) format. The electronic report may consist of text, figures, tables, maps, data files, etc. Reports in electronic format may contain color, (such that colors will print visibly in black and white). Files too large for email attachment may be sent to SMRI via an FTP site.
6. The final results of the research shall be presented in a 30-minute oral report at an SMRI meeting. The report may, at the discretion of SMRI, be at a members-only meeting, or as part of a technical conference. Any and all costs associated with the presentation are part of the contract and included in the contractor's proposal.
7. Upon SMRI acceptance of the final report, the Contractor shall send an invoice electronically to the SMRI Executive Director, Assistant Executive Director, Research Coordinator, Project Sponsor, and copy to [accounting@solutionmining.org](mailto:accounting@solutionmining.org) for approval and payment.
8. SMRI owns the copyright and has the sole right to distribute the report and research products in all versions and formats, including the right to charge for it. The Contractor may distribute the report without charge within the Contractor's organization.
9. SMRI has the right to cancel the contract for any reason and at any time. Should SMRI elect to do so, it shall reimburse the contractor for all costs incurred through the cancellation, unless the cancellation is due to inadequate or late performance.
10. SMRI will not pay any costs or reimburse any expenses not specifically included in the contract. Any changes to the contract must be approved in writing by SMRI and the researcher prior to such additional work or expense. Full costs of the project will be paid by SMRI upon acceptance of the final report by the Research Committee, unless partial payments are specified in the proposal and contract.