Cold Working Thread Roots with CNC Lathes for Rotary Shouldered Connections

API TECHNICAL REPORT 7CR
FIRST EDITION, JANUARY 2020

AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

Classified areas may vary depending on the location, conditions, equipment, and substances involved in any given situation. Users of this technical report should consult with the appropriate authorities having jurisdiction.

Users of this technical report should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to ensure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be used. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

The verbal forms used to express the provisions in this specification are as follows:

— the term "shall" denotes a minimum requirement to conform to the standard;

— the term "should" denotes a recommendation or that which is advised but not required to conform to the standard;

— the term "may" is used to express permission or a provision that is optional;

— the term "can" is used to express possibility or capability.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

Contents

Contents

Figures

Contents

Page

Tables

Introduction

Users of this technical report should be aware that further or differing requirements may be needed for individual applications. This technical report is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this technical report and provide details.

In API 7-2, the term “cold worked (CW)” is used and not “cold root rolling”. This is done on purpose to be able to use multiple methods (such as shot peening) to deform the thread root. Thus, shot peening is acceptable. For any other method chosen, the thread height shall be gauged and recorded before the cold root rolling is done.

Thread root rolling has been performed on rotary shoulder connections and was first introduced by L. E. Trishman [2]. The purpose of CW is to put the thread root into a compressive state by yielding the surface of the thread root, burnish away tooling scratches, and blend the root radius into the load and stab flanks. In the early days of machining rotary shoulder connections, cutting tools were hand ground to produce the thread form. The shape of the cutting tools was left more to imagination and less to quality control methods. It wasn’t until the induction of press carbide in the 1970s that threading inserts were made accurate enough to produce connections on a consistent basis. There are still procedures in effect today that require 1 RPM spindle speeds and 3 to 4 roller passes over the finished machined thread. None of the current procedures have stayed up with the technologies of CNC lathes to date regarding spindle speeds and single pass deformation of the root form. It is not known when the root roller radius was made larger than the threading insert radius, but this could be one reason why it has not been recommended to inspect standoff using ring and plug gauges after cold root rolling. Without procedures on how to align the CW roll to the threading tool paths is another cause of standoff change.

The radius on the CW roller has never been officially defined. Some suppliers use the same radius as the connection thread and others use a larger radius because of non-API requirements. This technical report will show the effects produced by a different root radius on the thread form.

Cold Working Thread Roots with CNC Lathes for Rotary Shouldered Connections

1 Scope

This technical report describes procedures for cold root rolling the thread roots on API 7-2 thread sizes using CNC Lathes (CW/CNC). Cold working can be applied by two methods: 1) cold rolling under pressure with a roller shaped like the thread form or 2) shot peening. Both methods achieve acceptable results, but machine thread root rolling is more controllable.

It is not the intent of this technical report to explain the benefits of thread root rolling, but the manufacturing process and quality control requirements. This technical report will address the best practices (or recommended practices) to cold root roll API 7-2 threads and identification marking.

This technical report will not address cold root rolling using manual lathes (CW/Manual)—a similar process but with different tools used for the pin and box. However, the tools described in this technical report can also be used on manual lathes. The steps to position the CW roll into the thread and the paths the tools move can vary between CNC machines controls.

2 Normative References

This technical report contains no normative references. For a list of documents and articles associated with API TR 7CR, refer to the bibliography.

3 Terms and Definitions

For the purposes of this technical report, the following terms, definitions, and abbreviations apply.

3.1
cold working
CW
Plastic deformation of the connection surface at a temperature low enough to induce strain hardening.

3.2
deburr
Removal of burrs or stringers created by the threading tool.

3.3
following error
The difference between where the "z" axis is based on feedback from the spindle encoder, and where it should be, based on what the CNC control program has commanded.

3.4
full-depth thread
A full formed thread in which the thread root contacts on the minor cone of an external thread or contacts on the major cone of an internal thread.

3.5
G-code
The common name for the most widely used numerical control (NC) programming language.