Available online at www.sciencedirect.com
SCIENCE DIRECT
Engineering Failure Analysis 13 (2006) 1358–1369
ENGINEERING FAILURE ANALYSIS
www.elsevier.com/locate/engfailanal

Cause and effect assessment after a complex failure of a large ethylene compressor

P.G. Fazzini [1], A.A. Márquez [2], J.L. Otegui *, P. Barcia [3]

Welding and Fracture Division, INTEMA, University of Mar del Plata, Juan B. Justo 4302, 7600 Mar del Plata, Argentina

Received 26 August 2005; accepted 24 October 2005
Available online 31 January 2006

Abstract

A rusted cylinder liner and excessive wear of piston rings forced several maintenance disassemblies in a 1000 kW ethylene reciprocating compressor. Several months later the compressor failed due to growth of cracks in the crosshead of one of the cylinders. The initiation site was located in material defects near a stress raiser. In order to identify the root cause of the failure, crack growth time calculations were required. The applied stress field near the initiation sites and along fatigue paths were FEM estimated. Stresses vary steeply and become partly compressive along a large part of one of the fatigue crack paths. A recently developed weight function based numerical method was used to assess total fatigue crack growth time; this method also predicts the shapes of the crack front during propagation. Fatigue crack initiation was traced to a disassembly six months before final failure, which was found to be a joint result of non-conformities in manufacture and maintenance.

Keywords: Reciprocating compressor; Failure analysis; Defect assessment; Mechanical modeling

1. Introduction

This work describes the methodology developed to determine the origin and reasons of a major failure in an ethylene compressor at a petrochemical plant, and to develop mitigation methodologies to reduce probability of future failures in similar equipment. The reciprocating ethylene compressor is used in the first stage of the process of polyethylene production. This compressor has two cylinders, identified as A and B, and failed after the crosshead and crosshead liner of cylinder B broke. Fig. 1 shows a diagram of parts related to the crosshead of cylinder B [1]. Subsequent turns of moving parts (especially the connecting rod

* Corresponding author. Tel.: +54 223 481 6600; fax: +54 223 481 0046.
E-mail address: jotegui@fi.mdp.edu.ar (J.L. Otegui).
[1] Present address: INTEMA, Comision de Investigaciones Cientificas Bs. As., Argentina.
[2] Present address: P. Engineering, GIE S.A., www.giemdp.com.ar.
[3] Present address: PbbPolisur, Dow Co.

1350-6307/$ - see front matter © 2006 Published by Elsevier Ltd.
doi:10.1016/j.engfailanal.2005.10.005

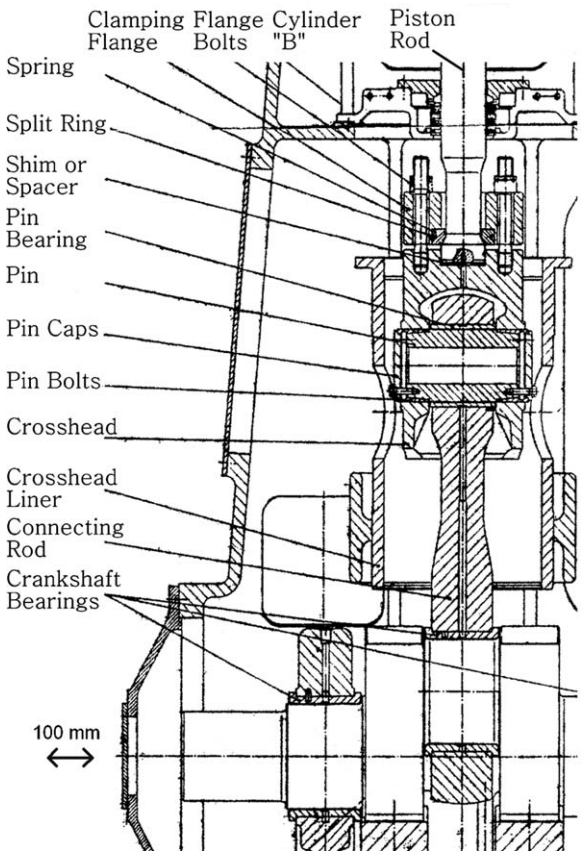

Fig. 1. Diagram of parts related to the failed crosshead of cylinder B. comp. C111.

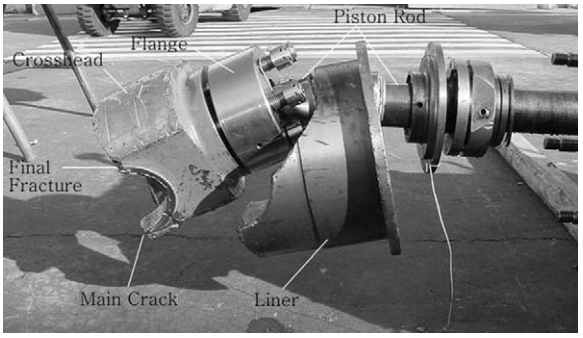

Fig. 2. Massive damage to crankcase and other parts.

of cylinder B) provoked massive damage to crankcase and other parts, these can be seen after disassembly in Fig. 2.

Two weeks before failure, maintenance personnel had been working on the machine to replace piston rings. In order to define causes, mitigation measures and contractual responsibilities, a failure root cause analysis was carried out, the characteristics of several cracks and other defects present in the affected pieces were analysed, defining material properties, and performing mechanical models. Main characteristics of the compressor are: capacity 1200 Nm^3/h, suction and final pressures, 25 and 70 bar g, crankshaft angular velocity 400 rpm, compressor piston stroke 250 mm and 1000 kW rated power.