

**INCREASING RATE OF HYDROGEN PERMEATION THROUGH PIPES
AND VESSEL WALLS**



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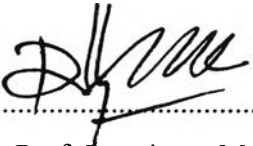
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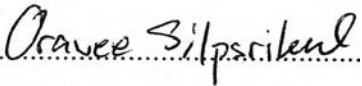

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บทคัดย่อ

สุภาวดี รัตนพันธ์: ชื่อหัวข้อวิทยานิพนธ์ การเร่งอัตราการแพร่ของไฮโดรเจนผ่านท่อและผนังภาชนะโลหะ (Increasing Rate of Hydrogen Permeation Through Pipes and Vessel Walls) อ. ที่ปรึกษา : รศ.ดร. ชีรศักดิ์ ฤกษ์สมบูรณ์, ศ.ดร. แฟรงค์ อาร์ สจีวิต, แอนดรู จัสต์อะซัน และ เคลลี แมคคีน, 96 หน้า

ไฮโดรเจนสามารถแพร่เข้าสู่เนื้อโลหะในรูปของไฮโดรเจนอะตอมซึ่งไฮโดรเจนมาจากกระบวนการกัดกร่อนหรือไฮโดรเจนจากกระบวนการผลิตในอุตสาหกรรม อะตอมไฮโดรเจนแพร่เข้าสู่โลหะได้เนื่องจากมีขนาดเล็ก เมื่อแพร่แล้วรวมตัวกันเป็นก๊าซไฮโดรเจนจึงมีแรงดันสูงจึงลดความแข็งแรงของโลหะลงสามารถทำให้เกิดการแตกร้าวจากไฮโดรเจน (Hydrogen Embrittlement) ดังนั้นจำเป็นต้องเพิ่มอัตราการแพร่ของไฮโดรเจนในเนื้อโลหะเพื่อป้องกันการเสื่อมสภาพของโลหะ งานวิจัยนี้ศึกษาการแพร่ของไฮโดรเจนผ่านเหล็กกล้าและแฮสเทลลอยด์ซึ่งเป็นโลหะที่ใช้อย่างแพร่หลายในอุตสาหกรรม งานวิจัยทำการศึกษาปัจจัยของอุณหภูมิและอุณหภูมิต่ำที่สุดที่ไฮโดรเจนสามารถแพร่ผ่านได้ โดยศึกษาผลกระทบของฟิล์มออกไซด์ซึ่งเกิดที่ผิวด้านนอกของโลหะและประพืดัวเป็นฟิล์มด้านทานการแพร่ ฟิล์มนี้มีผลมากต่อเหล็กกล้า แต่เกือบไม่มีผลต่อแฮสเทลลอยด์ นอกจากนี้ได้ศึกษาผลกระทบของการเคลือบตัวเร่งปฏิกิริยาแพลเลเดียม (Pd) ที่ผิวนอกของท่อโลหะเช่นกัน โดยเปรียบเทียบอัตราการแพร่ของท่อที่เคลือบตัวเร่งปฏิกิริยาและท่อที่ไม่ได้เคลือบตัวเร่งปฏิกิริยา ผลการวิจัยพบว่าตัวเร่งปฏิกิริยาสามารถเร่งอัตราการแพร่ของไฮโดรเจนอย่างชัดเจนกับเหล็กกล้า แต่ไม่สามารถเร่งอัตราการแพร่ของไฮโดรเจนผ่านแฮสเทลลอยด์

ABSTRACT

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Hydrogen can enter in a metal during corrosion processes or other industrial processes. Atomic hydrogen can diffuse through the metallic lattice because of its small size. Its interaction can result in various types of embrittlement. Therefore, efficient hydrogen removal is desirable. In this work, hydrogen permeation was studied in carbon steel A-179 and Hastelloy C-276, which are commonly used as structural material for equipment in industry. Diffusion of hydrogen was measured using gas phase permeation techniques. The effect of temperature on hydrogen transport has been investigated. The minimum temperature ranges that hydrogen can diffuse through these two metals were determined. It was found that the lowest temperature of hydrogen permeation through carbon steel is in the range of $90 \leq T \leq 150^\circ\text{C}$ and $200 \leq T \leq 250^\circ\text{C}$ for hastelloy. Passive oxide films were allowed to form on the outside surface of tube used in the tests. In the permeation mechanism, the iron oxide films behave as a barrier to hydrogen transport. The effect of a catalyst covering the outside surface was studied. The metal was coated with palladium to compare the diffusion rate with and without the presence of palladium on the outside tube surface. A palladium coating on the external surface of carbon steel gives a higher hydrogen permeation rate whereas there is no noticeable effect on hydrogen permeation rate through hastelloy.

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