



CALIFORNIA STATE SCIENCE FAIR 2006 PROJECT SUMMARY

Name(s) Heather M. Barnes	Project Number J1104
Project Title The Effects of Arrhenius Accelerated Aging on O-rings	
Abstract Objectives/Goals On January 28, 1986 America was shocked by the o-ring malfunction which led to the obliteration of the space shuttle Challenger, and the death of its seven crew members. My project examines the relationship between age and strength of o-rings. I used the Arrhenius equation in this experiment to artificially age o-rings through heating. I compared the strength of artificially aged o-rings to those naturally aged by time and newer o-rings. I applied the Arrhenius equation and calculated the length of time and temperature required to age nitrile o-rings. According to the equation, the o-rings were aged for four and one half years, six years, seven and one half years, nine, ten, fifteen and twenty years. These artificially aged o-rings were tested for strength and elongation against the same type of Nitrile o-rings that were either new or truly four and one half years old. Methods/Materials To determine ultimate strength an empty five-gallon (20 liter) bucket was hung from a step ladder by an o-ring. The bucket was filled with sand until the o-ring broke. The weight at which the o-ring broke was recorded. A second test was conducted with an #elongation machine# I constructed. In the elongation device o-rings where stretched until they snapped. The length at which the o-rings failed was recorded to the nearest tenth of a centimeter. Results After testing a sample size of two hundred o-rings these were the results. New o-rings failed at an average ultimate tensile strength of 18.1 MPa (29.3 kilograms; 287.1 Newtons). Aged o-rings failed at 5.9MPa to 7.5 MPa. The ultimate strength decreased gradually but consistently with age. For the second test on average new o-rings stretched to approximately 3.9 times their natural length (an elongation percentage of 390%). Aged o-rings were not quite as elastic and stretched to only 3.3 to 3.7 times their original length. The elongation capacity decreased over time. Conclusions/Discussion The results of the elongation tests demonstrated that o-rings lose elasticity, don#t stretch as far before breaking, as they age. The results of the ultimate strength tests showed that o-rings gradually lose tensile strength in the first twenty years of aging. All results in these tests show that o-rings lose tensile strength and elasticity over time and may malfunction in use as a result of the aging process.	
Summary Statement This project examines the effects of natural and accelerated aging on o-rings as demonstrated by elongation and ultimate strength tests.	
Help Received Thanks to my dad for helping build my machine (for safety precautions); Thanks to my teacher, who for proof reading my report.	