

# The use of Piezo Materials in Boiler Monitoring

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Before...



**After!!!!!!?**



# Causes

- Scaling
- Corrosion
- Cracks
- Over-Pressure & Temperature
- Bad manufacturing process

# Piezoelectric

- The ability of certain salts and crystals to generate a voltage under stress and also deform if a voltage is applied
- Polycrystalline ceramic materials
- No need for an amplifier as in the use of strain gauges
- Easy to fabricate into any size and shape

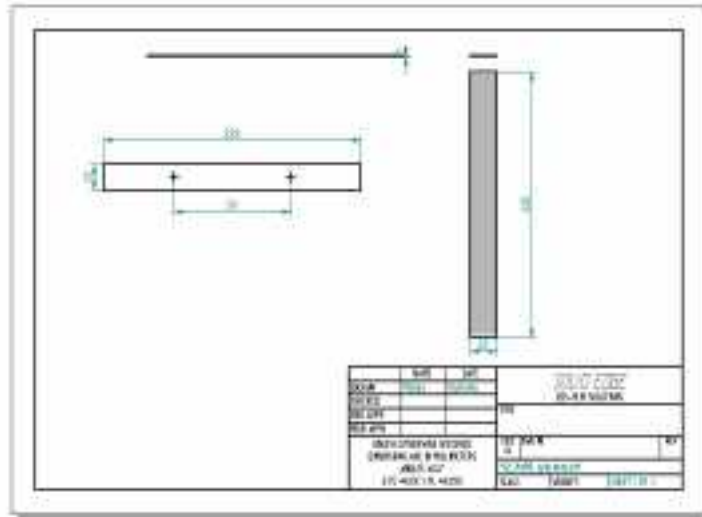
# Properties cont...

- Mechanically hard and robust
- Chemically inert
- Unaffected by atmospheric humidity
- The temperature ranges for the use is 45°C - 500°C
- First used in the First World War as an ultrasonic submarine detector

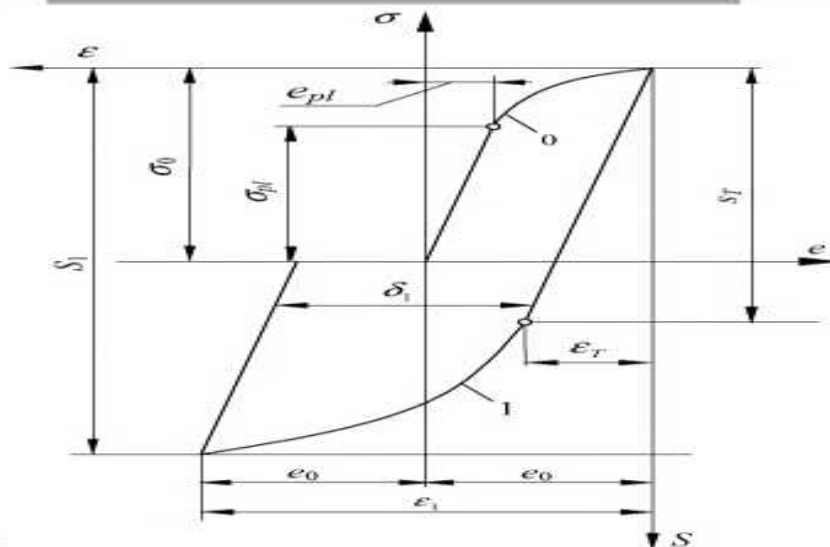
# Applications

- Fuses for explosives
- Strain excitation gauges
- NDT transducers
- Dynamic force and pressure measurement
- Vibration measurements
- Ultrasonic sensor
- Spark-ignition lighters

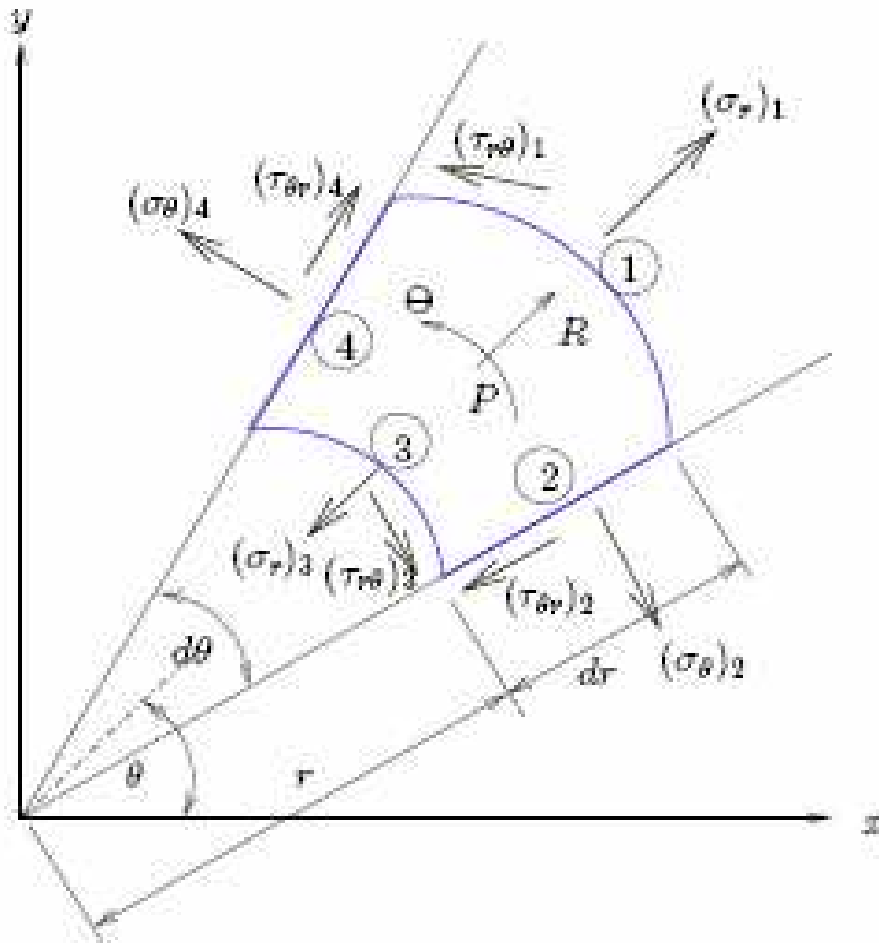
# Research into Piezoelectric



- Fatigue testing of metal material
- Stress and strain curve
- Fatigue properties



# Boiler/cylinder Theory



➔ Cylinder theory equations

$$S_{2,4} = \frac{pr}{t}$$

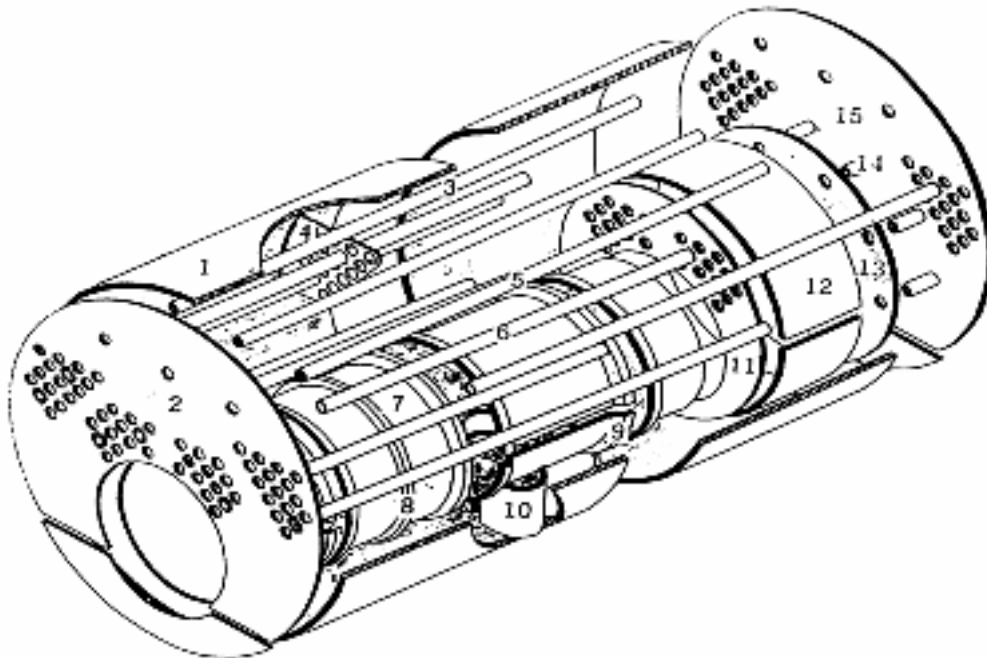
$$S_{1,3} = \frac{pr}{2t}$$

$$t_{\max} = \frac{pr}{2t}$$

$$e_x = \frac{S_{1,3}}{E} (1 - 2u)$$

$$e_y = \frac{S_{2,4}}{E} (2 - u)$$

# Proposed application



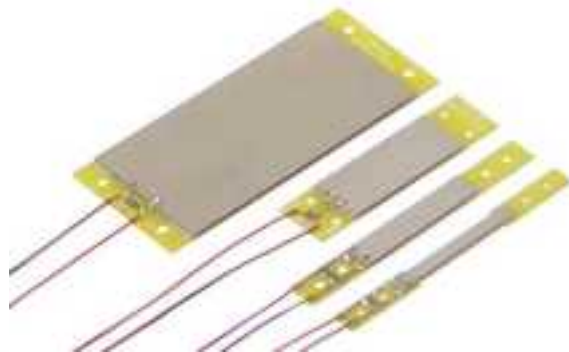
➤ Piezoelectrics in strategic places on the boiler

➤ SCADA

$$S_{hoop} = \frac{V_{out} \times r}{n \times t_{piezo} \times t_{boiler}}$$

$$S_{longitudinal} = \frac{V_{out} \times r}{2 \times n \times t_{piezo} \times t_{boiler}}$$

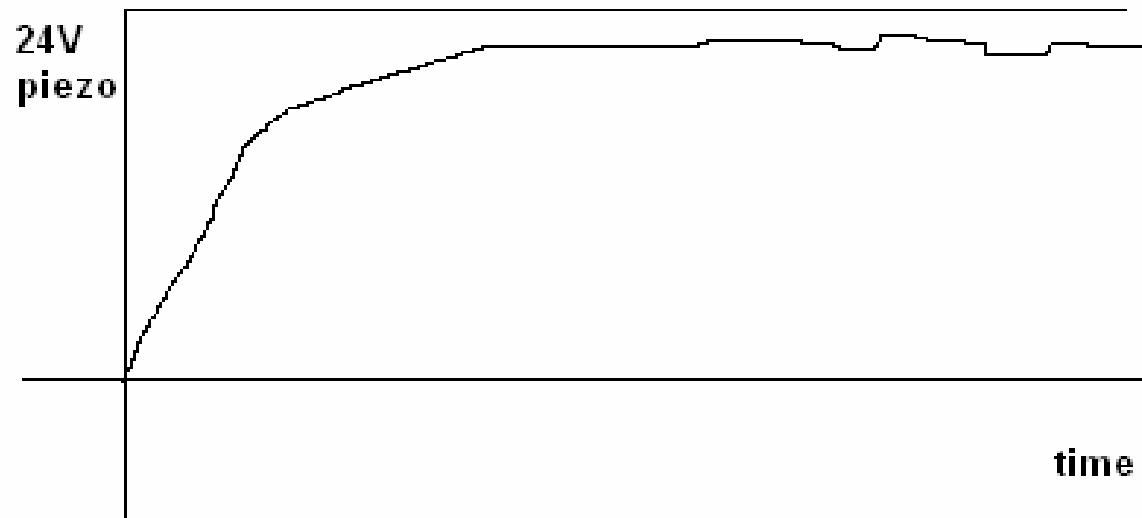
$$t_{max} = \frac{V_{out} \times r}{2 \times n \times t_{piezo} \times t_{boiler}}$$



# Proposed application

- First order response
- Time versus boiler shell stress curve

first order response

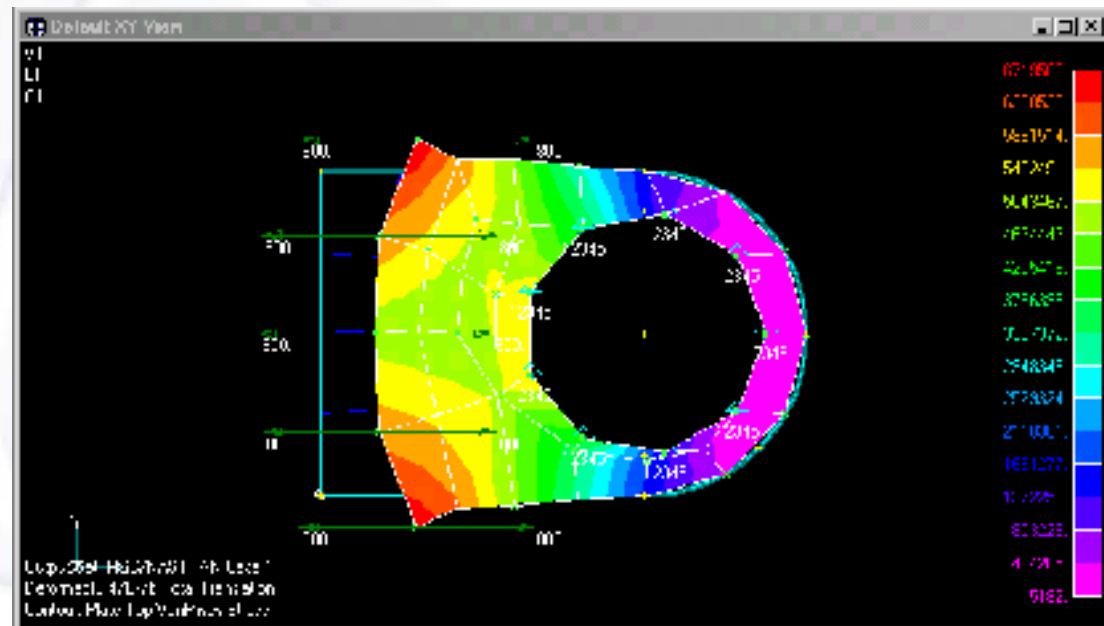
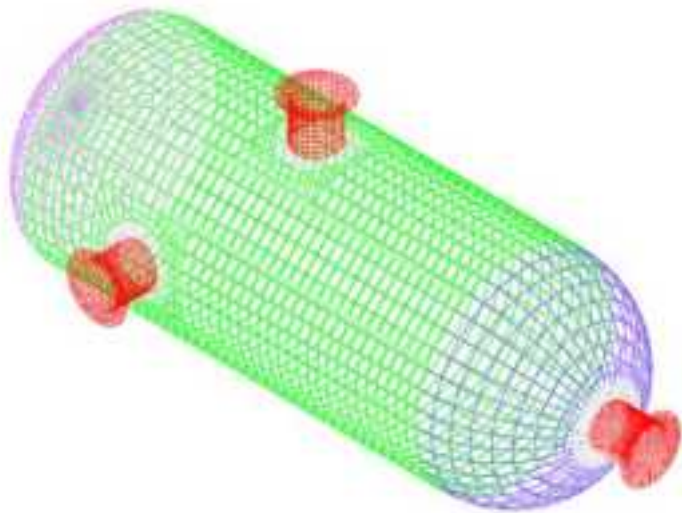


# Function

- To measure the stresses applied to the boiler shell
- To be able to monitor the boiler in terms of the material behavior
- To be able to predict boiler failure
- Better boiler maintenance scheduling

# Endless possibilities

- ➔ Merging with Nastran software for modeling



# Conclusions

- ▶ Piezoelectric materials
  - Easy to use
  - Cost effective
  - Better response than strain gauges
  - Low on maintenance

# Conclusions

- Assess your safety standards
- Assess your machines
- Explore new ideas