

2017 International Perforating Safety Forum



Recovery of Perforating Guns where the Explosives are Thermally Overexposed

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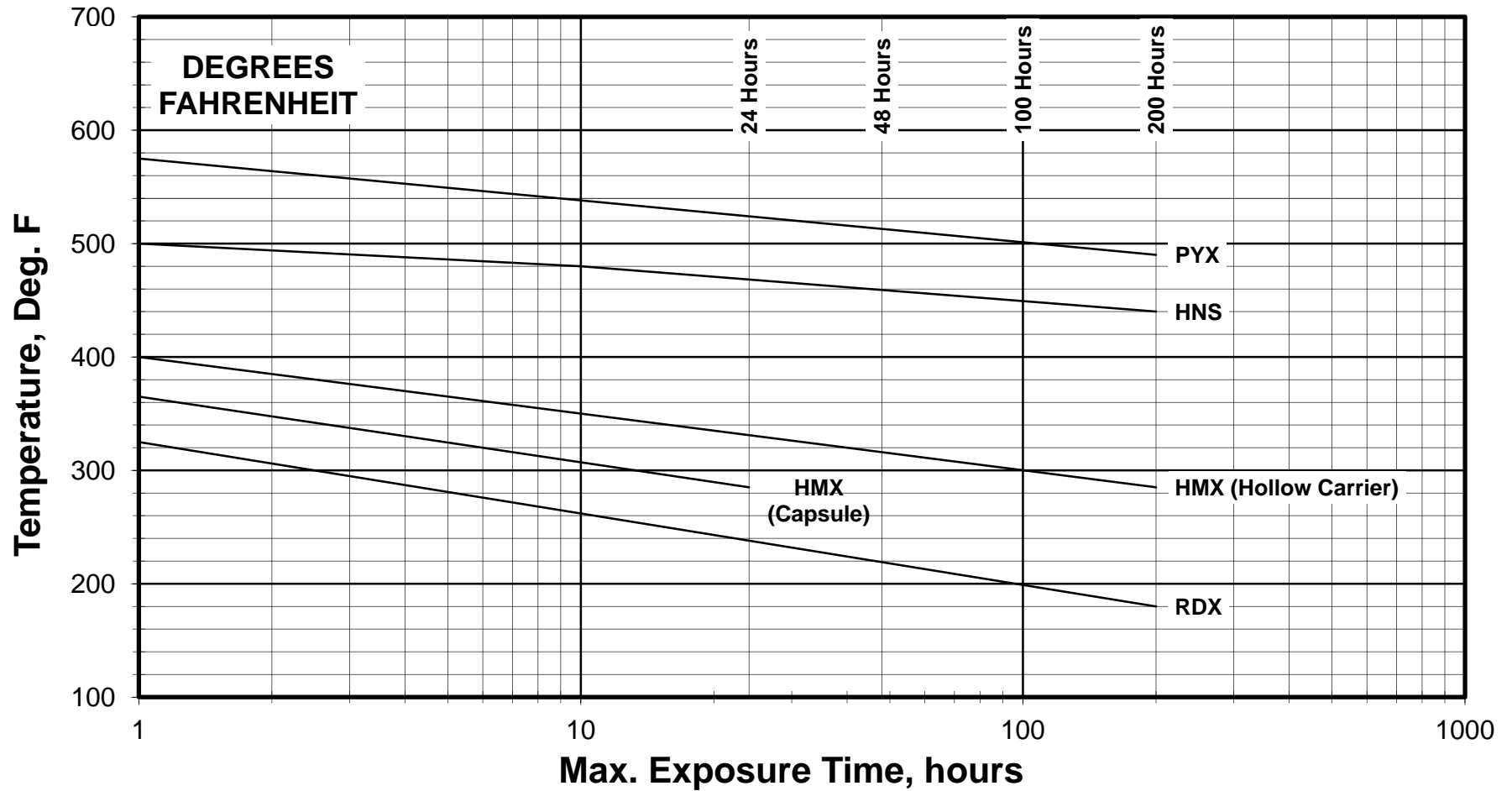
Agenda

- Basic Definitions
- Time versus Temperature with Explosives
- Issues regarding Thermally Overexposed Explosives
- Basic Procedures
- Safety Items to be aware of
- Conclusions

Definitions

- High-Order Detonation “Detonate”
 - Chemical reaction that exceeds the speed of sound
 - RDX detonation velocity ~ 22,000 – 26,000 fps (6700 – 7900 mps)
 - HMX detonation velocity ~ 26,000 – 30,000 fps (7900 – 9100 mps)
- Low-Order Deflagration “Deflagrate”
 - Many times we refer to this as a “low-order burn”
 - Much less than the detonation velocity
- API RP-67 is a “Recommended Practice” and not a “Required Practice”
 - Each company may have their own interpretation

Time Versus Temperature

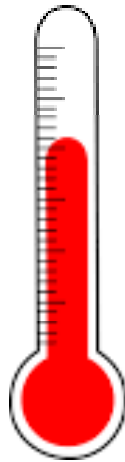


Time Versus Temperature Concerns

- No Safety Factors involved – again, customer specific
- Clock starts once the perforating guns drop below the rig floor
- Interpretation of this chart is Customer Specific



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API RP-67 4th Edition

- Still under review by API
- There will be a section for Thermally Overexposed Explosive Devices

Recommendations for recovering “possible” Thermally Overexposed Explosive Devices

- If there is a scenario where you believe that the perforating guns did not detonate, or you did not attempt to detonate the guns
 - And You believe the explosives were thermally overexposed
 - The well is not flowing after attempted detonation
 - The well is not showing any sign of perforating holes in the casing
 - You pumped the perforating guns off of the line and fishing operations have exceeded time versus temperature
 - The operation was delayed due to surface conditions, or well conditions, or weather, or catastrophic rig event
- You believe you will pulling out perforating guns that are Thermally Overexposed – here is a “recommended” guideline to follow:

Thermally Overexposed Explosives Recommendation

- Step 1
 - Have a meeting between the service company and the operator
 - Discuss all of the possible scenarios that were taken to determine what occurred downhole
 - Determine the time these explosives have been exposed to the BHT
 - Make sure the BHT is correct from logs, or temp gradients, or previous runs, or from other wells in this area
 - Discuss differences between OH and CH BHT
 - Discuss ALL of the explosives that are in the perforating gun system
 - Detonator or Initiator
 - Detonating Cord
 - Shaped Charges
 - Boosters
 - Determine the lowest temperature rating of all devices

Thermally Overexposed Explosives Recommendation

- Step 1 (cont)
 - When in doubt about the ratings of devices - refer to the MSDS sheets
 - Refer to specific company recommendations and procedures
 - If there is no specific recommendation, refer to RP-67 as a guideline
 - Design a plan that all parties agree upon to retrieve the perforating guns
 - Determine what items will be necessary at the surface in order to properly handle the perforating guns
 - Piercing Tool for pressure relief?
 - IR Thermometer for accurate temperature readings?
 - Water hose or availability of water?

Thermally Overexposed Explosives Recommendation

- Items to Consider at this point
 - How long do you want to let the guns cool off before you reach surface?
 - Possible solution is to find a zone up the hole but not at the surface that IF the guns were to detonate – then this zone would work in the event of a possible detonation
 - Determine the time to stay at that zone based on temperature at that depth
 - Recommend at least 30 minutes at this depth – extended time is always on your side

Thermally Overexposed Explosives Recommendation

- Step 2
 - Conduct a Safety Meeting between ALL parties on location
 - Review Safety Procedures and Policies
 - Outline specific instructions for all personnel when the perforating guns reach the surface
 - What to do if the guns did fire
 - What to do if the guns did not fire
 - Necessary personnel on the rig floor

Thermally Overexposed Explosives Recommendation

- Step 3
 - Begin Pulling out of the well with the perforating equipment
 - Do not get in a hurry and “assume” that the perforating guns did not detonate and you have “live guns” coming out of the well
 - Continue to monitor the well for any possible sign of detonation
 - Pull up to the agreed location in the well for the perforating guns to “cool off” for an agreed amount of time
 - At this point it would not hurt to conduct another safety meeting
 - Key personnel
 - Safe Areas
 - Proper handling equipment
 - Emergency procedures
 - Once the agreed time is reached – continue to slowly pull the equipment out of the well

Thermally Overexposed Explosives Recommendation

- Step 4
 - Bring the perforating gun assembly out of the well and make a visual inspection
 - If the perforating guns have detonated – proceed with reverse EBBA
 - If the perforating guns low-ordered and there are visual signs of high pressures escaping the assembly – Carefully inspect all of the perforating guns (if applicable)
 - If the perforating guns have not detonated or low-ordered
 - Record the time and take an external temperature measurement at a key location of the perforating gun
 - If an IR Temperature probe is not available then splash water on the perforating gun to see if boils or bubbles

Thermally Overexposed Explosives Recommendation

- Step 4 (cont)
 - If the temperature is above 212°F (100°C)
 - Clear the area and wait a couple of hours
 - At this point you should notify management of the situation
 - Continue to take temperature readings every 2 hours until the temperature begins to decline
 - Note: Be sure to take the temperature readings in the same spot on the perforating guns
 - If the temperature is less than 212°F (100°C)
 - Wait approximately 15 minutes and take another temperature reading to ensure the temperature is falling
 - At this point you would let the temperature decrease to where it is safe to handle and proceed with reverse EBBA and disassembly

Thermally Overexposed Explosives Recommendation

- Conclusions
 - Thermally Overexposed Explosives are very dangerous to handle at the surface
 - API Recommended Practices are just that – Recommended
 - Each company should have their own policies and procedures when dealing with Thermally Overexposed Explosives
 - Use the Time / Temperature chart to determine if the explosives have exceeded their time at temperature
 - Know the temperature ratings of ALL products (especially the explosives), along with the parts and pieces prior to going in the well with the perforating gun assembly
 - Never take short-cuts when dealing with explosives

- Better a thousand times careful than once dead - *proverb*

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QUESTIONS?
THANK YOU!

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