# Properties of Asphalt Binder After Extended Aging in a Pressure Aging Vessel

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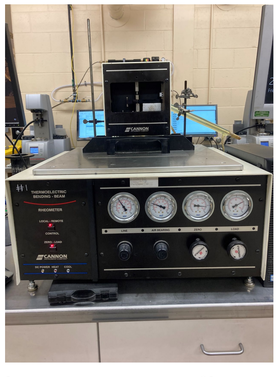
## Binder Aging

Asphalt binder is subject to two forms of aging. Short term aging is generally caused by the loss of aromatic oils. Long term aging is more associated with the absorption of oxygen. Both of these aging processes can be simulated in a laboratory environment.

Figure 1. A Rolling Thin Film Oven (RTFO) (left) and a Pressure Aging Vessel (PAV) (right)

## Methodology

Normally the binder is aged in the PAV at 100°C and 2.1 MPa of pressure for 20 hours. This research takes this a step further by exposing the binder to this environment for 40 hours. The binder is then tested at a range of low temperatures to interpolate the critical cracking temperature ($T_{c,s}$) and critical rate of relaxation temperature ($T_{c,m}$). These are used to find a value called $\Delta T_c$.



$$T_{c,S} = T_1 + \left(\frac{(T_1 - T_2) * (\text{Log } 300 - \text{Log } S_1)}{\text{Log } S_1 - \text{Log } S_2}\right) - 10$$

$$T_{c,m} = T_1 + \left(\frac{(T_1 - T_2) * (0.300 - m_1)}{m_1 - m_2}\right) - 10$$

where,

$S_1$ = creep stiffness at $T_1$, MPa,
$S_2$ = creep stiffness at $T_2$, MPa,
$m_1$ = creep rate at $T_1$,
$m_2$ = creep rate at $T_2$,
$T_1$ = temperature at which S and m passes, °C, and
$T_2$ = temperature at which S and m fails, °C.

Therefore, the equation for $\Delta T_c$ becomes:

$\Delta T_c = T_{c,S} - T_{c,m}$.

Figure 2. A Bending Beam Rheometer (BBR) (left) and the equations used to interpolate the results (right)

## Results

Research is still ongoing however we are almost ready to take the next step. Several other state agencies have adopted a minimum of -5 for acceptance of a 40-hour ΔTc result. Most of our binder samples fall well within the acceptable range. This gives us a good baseline for how an asphalt binder without low end modification can be expected to age and behave.

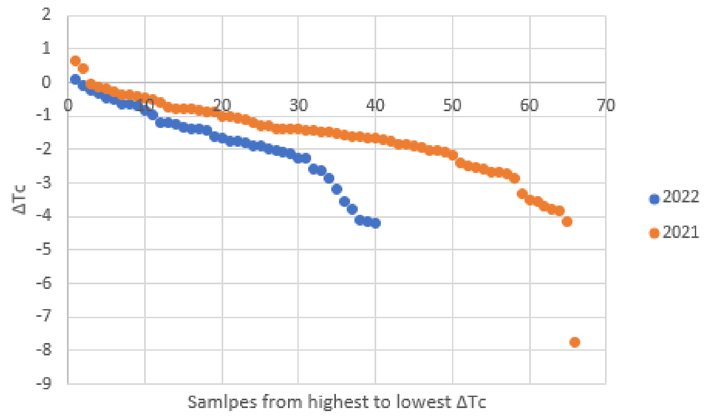



Figure 3. The range of $\Delta T_c$ results from 2021 and 2022

## OK… so what now?

We have gathered plenty of data on how our primary grades of asphalt age. Knowing this baseline, we want to give producers the opportunity to try and improve upon their formulations by allowing the use of low-end modifiers. Going forward we want to analyze how these chemicals effect the aging binder. Will they improve the life of the road? Is it cost-effective?

## Acknowledgments

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## References

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