SHIFT YOUR STRATEGY

GLASS PROCESSING AUTOMATION

GPAD

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Dealing with Glass Tempering Challenges, Enhancing Quality and Customer Satisfaction

Efficient Strategies for Waste Reduction and Cost Savings

Mike Synon
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HHH Equipment Resources

Introduction

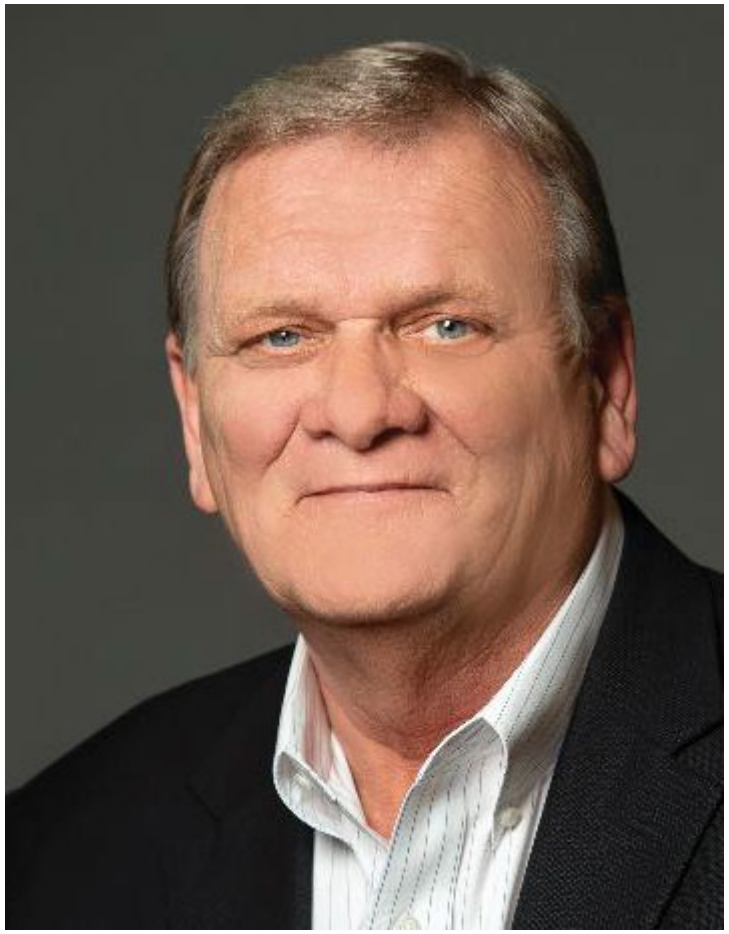
Welcome to our presentation on improving glass tempering processes.

Objective: Prevent Issues, Enhance Quality, and Reduce Costs.

Mike Synon

President,
HHH Equipment Resources

Mike Synon hails from the Midwest and has dedicated the majority of his professional career to the glass industry. As President of HHH Equipment Resources he oversees all aspects of machinery sales operations. Mike excels in cultivating robust relationships with clients and suppliers, a talent integral to the company's success. His profound understanding of the glass tempering process and ancillary equipment, has earned him widespread recognition and respect within the industry.



Terry Hessom

Vice President of Operations
HHH Equipment Resources

Terry Hessom is Vice President of Operations with HHH Equipment Resources. He possesses over 34 years of experience in the glass fabrication industry from facility operations management and project engineering to strategic planning and new machinery product and process expansion.

We sincerely apologize that Terry could not join us at GPAD this year. He made a commitment to Jury Duty today.

…or something like that.

Characteristics of Tempered Glass

- It is four to five times stronger than annealed glass.
- It has higher thermal strength, and it can withstand high temperature changes up to 250°C.
- It is difficult to break and even in the event of a breakage, disintegrates into small relatively harmless fragments.
- It is often referred to as “safety glass” for its ability to prevent spall and keep building occupants safe. Not to be confused with security glazing.

Importance of Quality

Quality is paramount in tempered or safety glass for several critical reasons:

Strength and Durability

Safety Standards Compliance

Reliability and Consistency

Resistance to Thermal Stress

Long-Term Performance

Importance of Quality

Strength and Durability: High-quality tempered glass ensures durability and resilience against impacts, making it suitable for various applications where safety is a concern.

Safety Standards Compliance: Ensuring high quality in tempered glass production is essential to meet safety standards and regulations, protecting end-users from potential hazards.

Reliability and Consistency: Quality control measures in tempered glass production ensure uniformity and consistency in glass thickness, strength, and optical clarity performing consistently across different applications, meeting performance expectations and providing peace of mind to consumers.

Resistance to Thermal Stress: High-quality tempered glass is less prone to thermal breakage, making it suitable for use in environments with extreme temperature variations.

Long-Term Performance: Quality tempered glass is less susceptible to surface flaws, scratches, and defects that can compromise its structural integrity over time minimizing the risk of premature failure or replacement costs.

Importance of Quality

In summary, ensuring high quality in tempered glass production is essential to meet safety standards, ensure durability and reliability, and provide long-term performance across various applications. Investing in quality tempered glass not only enhances safety but also contributes to overall customer satisfaction and confidence in the product.

Common Tempering Issues

Identify and address common tempering challenges:

- Meeting ANSI Z97 specifications consistently
- Quality edgework (polishing, seaming and why)
- Aesthetics (Visual perception of product)

The visual quality of tempered glass is becoming more important to the tempering business. The most important factor in glass quality is the control of heat transfer. This should be uniform over the glass plate and symmetric over the mid-plane of the glass.

Some common quality issues that arise in tempered glass include:

- ✓ Roller waves
- ✓ Bow/Warp
- ✓ Bad anisotropy (Strain pattern)
- ✓ White haze (The dreaded “skunk stripe”)

Root Causes of Issues

Understanding the root causes is crucial.

Factors like temperature variations, uneven cooling, or equipment malfunctions.

Root Causes of Issues

Roller Wave - During the heating process, the glass travels through the furnace on ceramic rollers, while traveling, the heated glass can slightly sag between rollers causing roller wave distortion. The severity of this optical effect is dependent on the glass temperature and related pliability.

- Keeping heating times to the absolute minimum will result in the least amount of roller wave.

Bow/Warp - Several factors can influence this anomaly. In essence, from either a differential in exit temperature and/or quenching rate, the surfaces can become rigid at different times allowing for more contraction on one portion of the glass than another. The various types of bow include: Straight Bow, Oilcan Bow, Saddle Bow, J-hook or S-Bow.

- Understanding the different bows, the specific cause, and the remedy is paramount for an operator to produce quality product with any degree of consistency.

Bad Anisotropy - Most commonly referred to as strain pattern, this visual effect is inherent to the tempering process but there are actions that can be taken to minimize the stress differentials that cause this.

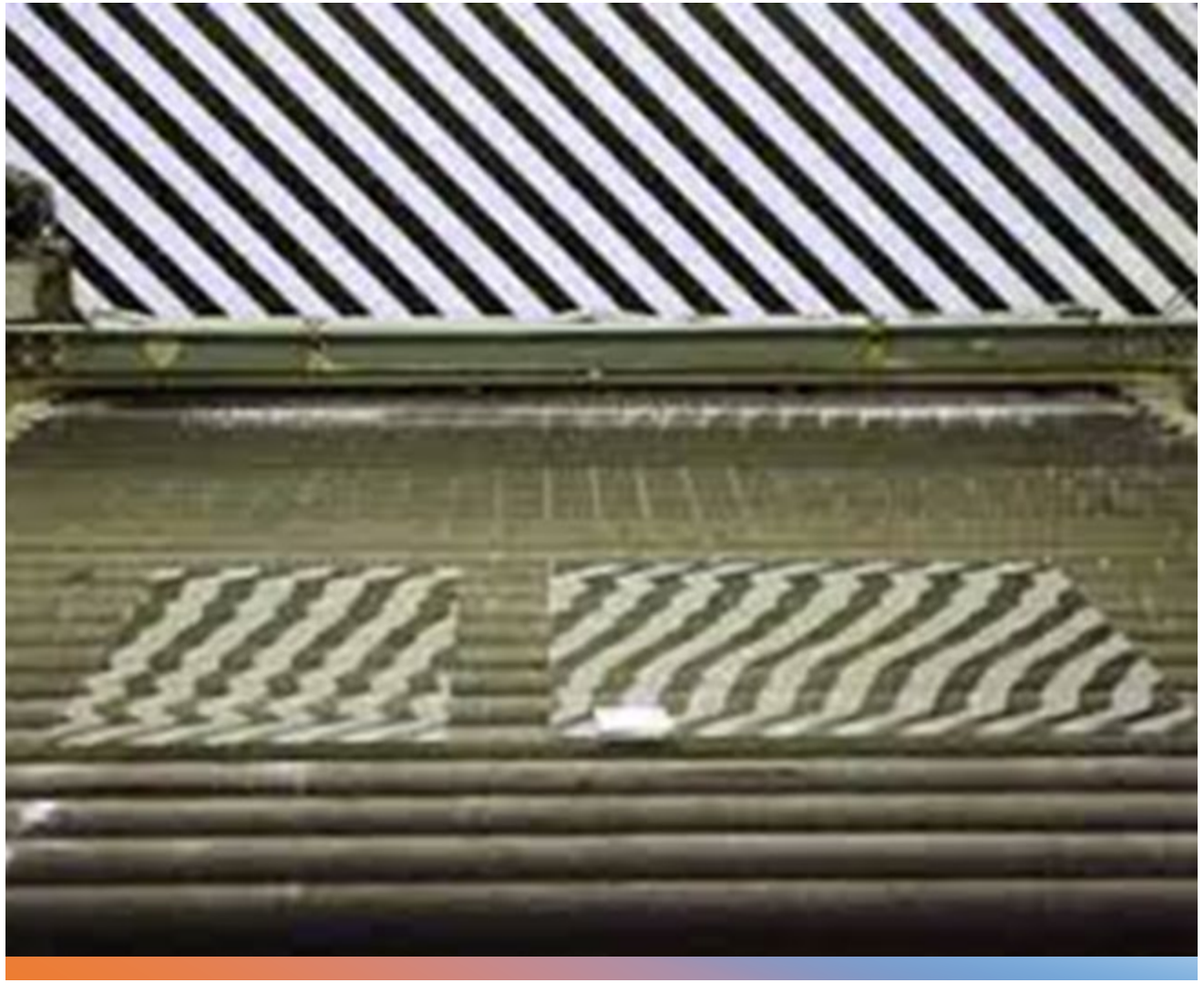
- Understanding how these differentials occur is the first step to determining which actions will reduce the visual effect.

White Haze - This defect is most commonly seen as a center scuff or stripe through the center of the glass, parallel to the direction of travel on thinner substrates. It can also be seen as scuff on the four outer corners on thicker substrates.

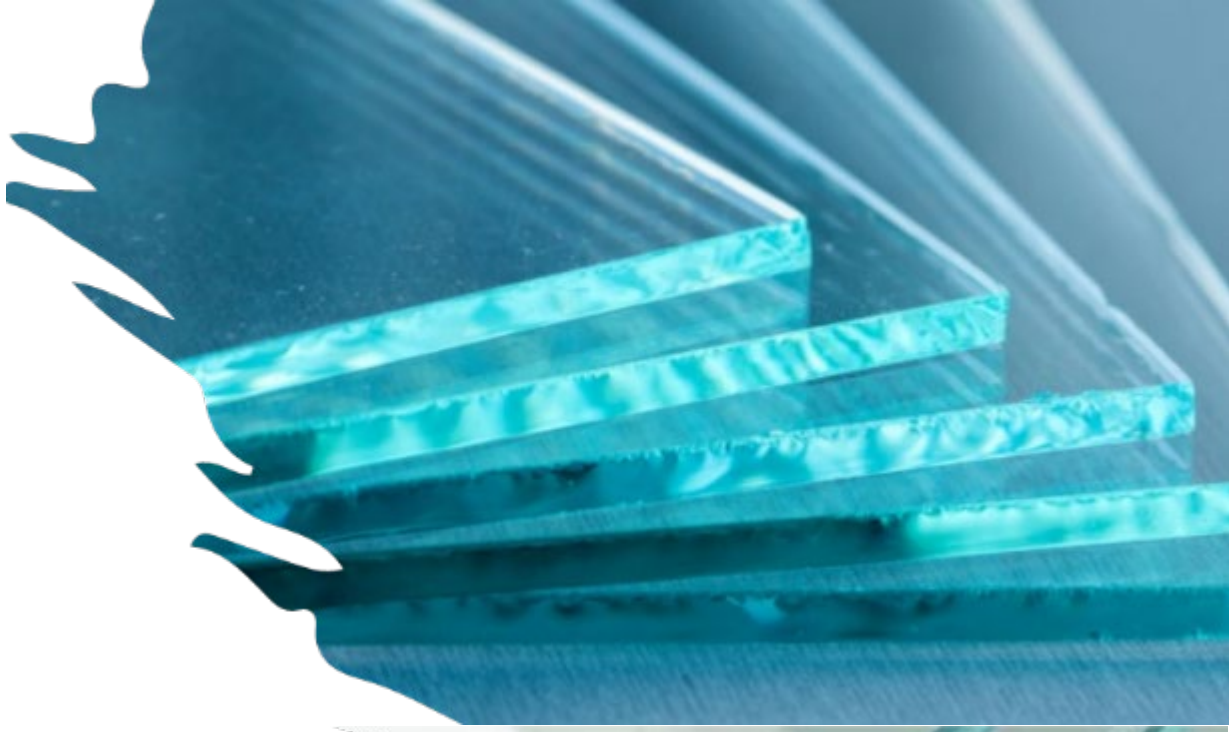
- Inconsistent heat rates cause the glass shape to change from flat. The resultant marks become the evidence of that shape change. Dirty rolls exacerbate the intensity of the effect.

Best Practices for Avoiding Issues

- Ensure your heaters, t/c's and controls are in good working order
- Ensuring the daily as well as the periodic maintenance is performed.
- Through the QC analysis, be sure quality is built into your processes.



Quality Improvement Strategies



Invest In Advanced Glass Processing Technology.

Implement Strict Quality Control Measures.

Employee Training Programs For Enhanced Skills.

Total Downtime Costs

Has your team experienced downtime agony?

Source 1: Direct Costs

Equipment
Labor

Source 2: Indirect Costs

Reallocated Maintenance and Management Time
- Production supervisor
- Quality control manager

Lost productivity

Source 3: Hidden Costs

Lost Customer Trust

Calculating Downtime Costs

$$
\begin{aligned}
\frac{1}{F(p;\xi)} &= 1+\frac{\alpha}{\pi p^2}\int_0^\infty dk\,\frac{k^2F(k;\xi)}{k^2+\mathcal{M}^2(k;\xi)}\left\{a(k,p)\left[-\xi\left(1-\frac{k^2+p^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|\right)\right]\right.\\
&\quad +b(k,p)\left[2(k^2+p^2)\left(1-\frac{k^2+p^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|\right)-\xi\left(k^2+p^2-\frac{(k^2-p^2)^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|\right)\right]\\
&\quad \left.-c(k,p)\left[2\left(1-\frac{k^2+p^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|\right)-\xi\left(1-\frac{k^2-p^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|\right)\right]\right\},\frac{\mathcal{M}(p;\xi)}{F(p;\xi)}\\
&= \frac{\alpha}{\pi}\int_0^\infty dk\,\frac{k^2F(k;\xi)}{k^2+\mathcal{M}^2(k;\xi)}\left\{a(k,p)\,\mathcal{M}(k;\xi)\left[(2+\xi)\frac{1}{kp}\ln\left|\frac{k+p}{k-p}\right|\right]\right.\\
&\quad +b(k,p)\,\mathcal{M}(k;\xi)\left[\frac{2(k^2+p^2)}{kp}\ln\left|\frac{k+p}{k-p}\right|+2(\xi-2)\right]\\
&\quad \left.+c(k,p)\left[\frac{(2+\xi)k^2+(2-\xi)p^2}{2kp}\ln\left|\frac{k+p}{k-p}\right|+(\xi-2)\right]\right\},
\end{aligned}
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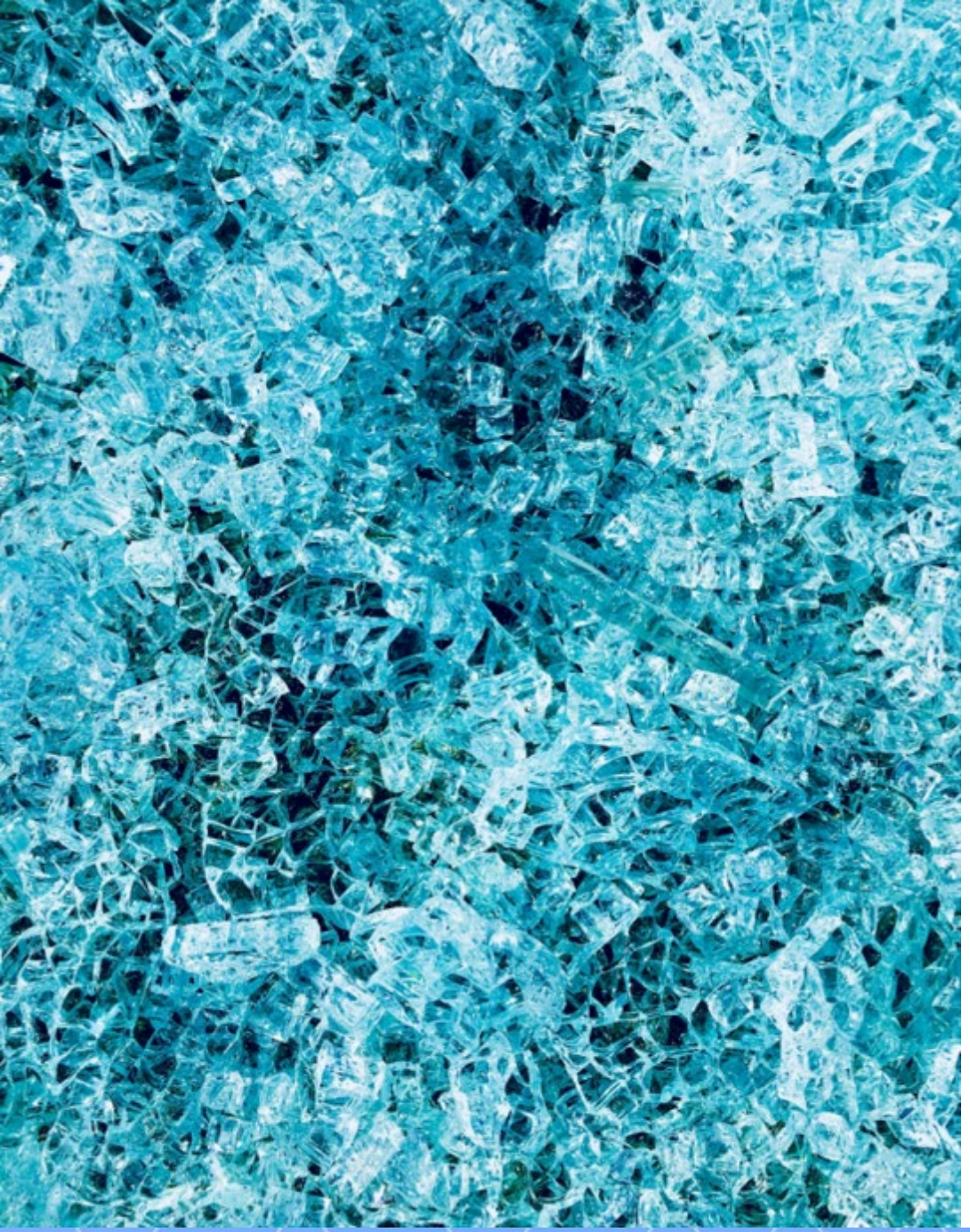
Cost Reduction Strategies

- Cut Waste by reducing breakage and rejected quality.
- Streamline production processes.
- Energy-efficient equipment for long-term savings.



Preventative Maintenance

Preventing Down Time

- **Equipment selection:** Purchasing the appropriate equipment for end-use prevents unnecessary wear and strain on your equipment.
- **Operator and maintenance training**: Ensure proper use and protection of your equipment with thorough operator and maintenance team training.
- **Tooling and supplies:** Maintaining machines with compatible tooling, parts and accessories prevents machine damage.
- **Repairs and replacements:** Completing repairs and replacing parts at the first sign of fatigue prevents further damage to your equipment.
- **Equipment expansion**: Adding additional equipment to your lineup as production needs grow prevents equipment from over-use and wearing out.

Monitoring and Continuous Improvement

Implement a robust monitoring system for ongoing assessment.

Encourage feedback from the production team For continuous improvement.

Case Study - Successful Implementation

- Sorting glass, post cutting, to provide optimized furnace bed loading supports a major part of the “consistent” aspect.
- Batching to reduce changeovers also provides additional consistency as well as throughput.
- Quality control analytics provide invaluable data to ensure the production processes are engineered to provide the desired quality across a broad spectrum of products.
- Strict adherence to a comprehensive preventive and predictive maintenance plan not only provides a high reliability factor but also customer confidence with reduced, unscheduled down-time.

Conclusion

- The importance of quality, cost-saving strategies - including preventing downtime, and waste reduction.
- The need for commitment to continuous improvement.

Questions?

Thank You

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