PCR microplate sealing and peeling for high throughput labs

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PCR plates and microplates usually require some type of seal to prevent evaporation, which otherwise may alter sample concentrations and impair repeatability.

Manual sealing and peeling of plates can be a low-cost process for low-throughput labs and workflows, however, as throughput increases so does the risk of associated hazards and constraints. These can include:

Repetitive strain injury

Downtime due to absence can have a clear link to lab throughput and potentially increase the demands on already high workloads. A common cause of lost workdays is carpal tunnel syndrome (CTS), which has seen a 500% increase over the past two decades leading to more lost workdays than any other workplace injury [1]. Working conditions and type of work have been established as more important than physical characteristics in determining the severity of neurocompression and return to work is more strongly influenced by working conditions rather than clinical factors or physical characteristics [1,3,4].

Occupational hand uses that are considered ergonomic risk factors include highly repetitive wrist movements and high pinch force, such as sealing and peeling plates. Repetition is the most recognised risk factor and is defined by the frequency of the task or the proportion of time spent on repetitive work.

Epidemiological studies have also considered high hand/finger grip force as a co-risk factor for CTS, based on the weight of the tool used or the impact.

Cross contamination & evaporation

Regardless of the level of training or attention, human errors can occur, or at least feature a level of inconsistency. In regard to manual sealing, hazards can come from a number of sources including:

- **Uniformity of seal across plate** – If uniform pressure is not applied to an adhesive seal at the right force it can lead to either poorly sealed or unsealed wells, which could result in evaporation of expensive reagents or even the movement of sample from one well to another.
- **Over sealing of wells** – In cases where too much force has been applied to the seal it may cause issues with peeling further downstream.
- **Non-proven heat-sealing methods** – In cases where 'homegrown' solutions have been established it can provide inconsistent sealing temperature or timing issues resulting in damaged seals or under sealed wells. These too can allow cross-contamination between wells or evaporation of sample and reagent.

Manual peeling methods can be equally risky and can present hazards such as:

- **Accidental mishandling** – Cross contamination can occur through the accidental mishandling of plates during peeling; if either plate or seal slips during peeling, samples can be forced to migrate from one well to another rendering the whole plate unusable.
- **Sample run off** – Depending on the angle of seal removal, it is possible for sample stuck to the underside of the seal through surface tension to 'run off' down the seal and into another well causing cross-contamination.

It is possible to mitigate the risk associated with the the above hazards, but it is not possible to remove the risk of human error without replacing it with a predictable automated solution.

Time lost due to bottlenecks

In many laboratories, manual de-sealing/resealing can consume hundreds of precious person-hours in just a few weeks of operation. In any organisation where high productivity is mission-critical - for instance, a competitive drug discovery operation – delays due to this bottleneck can mean serious setbacks for laboratory goals, or even for overall business plans.

Additionally, manual seal removal often forces a misallocation of human resources, and expensive automation is not being utilised to its fullest extent. Time spent manually de-sealing/resealing plates means that technicians cannot attend to more important projects to advance science [3].

Automated Roll Heat Sealer and Automated Plate Seal Remover (courtesy: Azenta Life Sciences).

Cost

The impact from evaporation of reagents and lost samples can be dramatic when performing high-throughput experiments, while cross-contamination of plates due to human error will also have an impact on lab resources. Both require assays to be repeated and lead to an increase in total reagent costs.

Facilities specifications

When choosing plate sealing/peeling equipment, it is important to consider the specifications of your laboratory. For example, some models of plate sealer require an external airline. Having to adapt existing labs to accommodate an external airline can be expensive and even more so when the downtime is considered. The plate sealer is then fixed to one location and cannot be easily moved unless external airlines are also adapted.

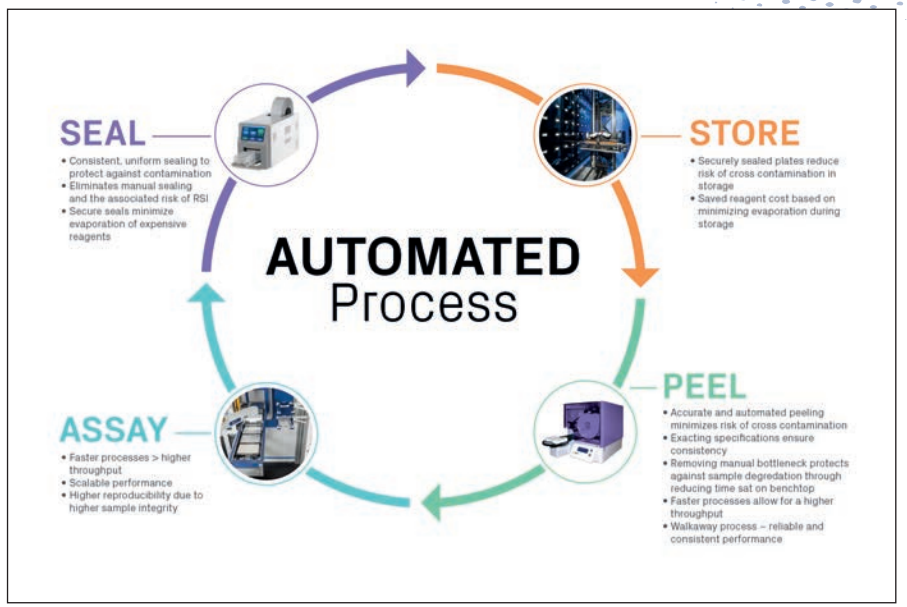
Bench or deck height can also be a limiting factor - with many automation platforms featuring low deck heights it can be a limiting factor to have to restrictions on height.

Automation to overcome the hazards of manual plate sealing & peeling

When looking for a solution that will help you reach the gold standard of sealing and peeling, it is important to consider the stated problems. There is a clear role for automation in mitigating the risks associated with the identified hazards and constraints as detailed in this infographic. One solution from Azenta Life Sciences combines the Automated Roll Heat Sealer and Automated Plate Seal Remover, to help you overcome concerns – from cross-contamination to facility requirements – as testified by Principal Scientist, Dr Vlad Zarayskiy, in the case study accompanying this paper [5].

Repetitive strain injury

Reducing the mechanical steps required by technicians by eliminating the need for repetitive, manual addition and removal of plate seals has a clear benefit in reducing the risk of RSI. The automated roll heat sealer, for example, can perform up to 5,000 seals without manual intervention.



Cross-contamination & evaporation

Automation enables optimum quality control through uniform secure sealing of plates – minimising evaporation of precious reagents and risk of cross-contamination - while accurate, automated peeling using the automated plate seal remover further reduces risk of cross-contamination from sample run-off.

Time lost due to bottlenecks

Automating plate sealing and peeling steps results in faster processing of plates and helps laboratories to increase throughput while also freeing up scientist time. Integration into robotic workflows further improves the workflow, providing a walk-away system.

Cost

Automated heat sealing of plates provides a reduction in cost compared to other sealing methods, such as caps or adhesive seals, while increased preservation of sample integrity through minimising cross contamination and evaporation, means that precious samples and reagents will be saved.

Facilities specifications

Eliminating the requirement for compressed air, the automated roll heat sealer can be installed quickly and has the flexibility to be moved within the laboratory either as a standalone benchtop unit or integrated robotic setup, independent of air supply.

References

1. Kao, YS. (2003) "Carpel Tunnel Syndrome As an Occupational Disease", JABFP, 16, (6), pp 533-542

2. Moore, JS., Garg, A. (1994) "Upper extremity disorders is a pork processing plant: relationships between job risk factors and morbidity", Am Ind Hyg Ass , 55, pp703-715

3. De Kesel, R., Donceel, P., De Smet, L. (2008). "Factors influencing return to work after surgical treatment for carpel tunnel syndrome", Occupational Medicine, 58, pp187-190

4. Shiri, R., Miranda, H., Heliovaara, M., Viikari-Juntura, E. (2009), "Physical work load factors and carpel tunnel syndrome: a population-based study" Occup Environ Med, 66, pp368-373

5. The Transformative Benefits of Automation in High Throughput Drug Discovery Workflows. Azenta Life Sciences White Paper (2019). https://www.azenta.com/resources/transformative-benefits-automation-high-throughput-drug-discovery-workflows