Plan your COVID-19 vaccine distribution using virtual lane risk assessment

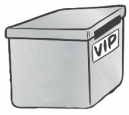
Stefan Braun, SmartCAE

COVID-19 vaccine distribution

The global distribution of upcoming COVID-19 vaccines poses a tremendous task on airlines and logistics providers. Not only are there billions of doses that need to be moved around the globe, also most of them need to be kept at very low temperatures, between -50°C and -70°C, throughout the transportation, due to vaccine stability requirements. To keep the payload at such low temperatures, it is necessary to use insulated containers filled with dry ice for distribution.

Dry ice containers

Dry ice containers require special handling. There are strict limitations in place on how much dry ice is allowed on board an aircraft, due to safety regulations. Depending on the type of aircraft, the amount of dry ice can be limited to 200 kg – per flight [1]. To distribute billions of doses, we cannot simply cram the cargo space with high performance containers, filled up with dry ice. Instead, we need to carefully plan how much dry ice is required and when re-icing has to be done to retain the temperature. If less dry ice can be used per container, more vaccine can be loaded for faster and more efficient distribution.

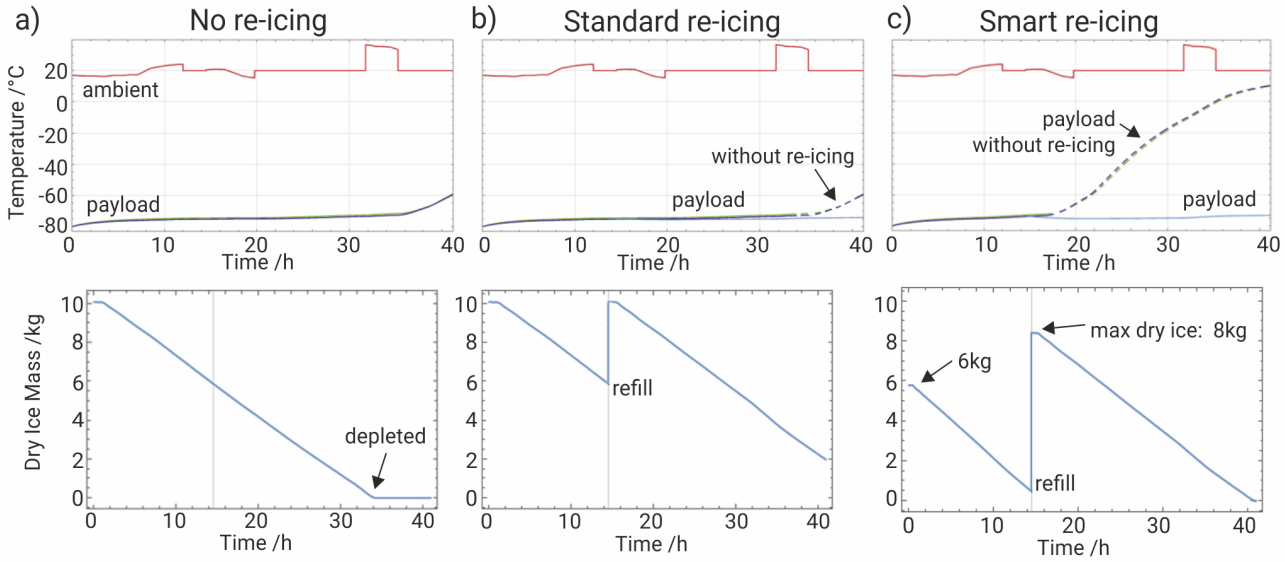
Lane	Box	Dry ice vol.	Payload vol.	Re-icing	Pass rate	Payload per flight
FCO-AMS-KUL	High performance 	High 	Low 	NO		1000 L
FCO-AMS-KUL *re-icing*	Standard 	Low 	High 	YES		1300 L

Virtual Lane Risk Assessment

Taking the classical approach to find out and validate the best strategy for each distribution lane would take months of extensive testing, causing inacceptable delays during the pandemic. A virtual lane risk approach cuts the time to a few days. It is much faster because it does not rely on physical test shipments, but uses accurate thermodynamic computer simulation to determine the performance of dry ice containers in lane-specific temperature conditions. Statistically, virtual lane risk assessments are even more reliable, because thousands of scenarios can be tested, unlike in physical testing.

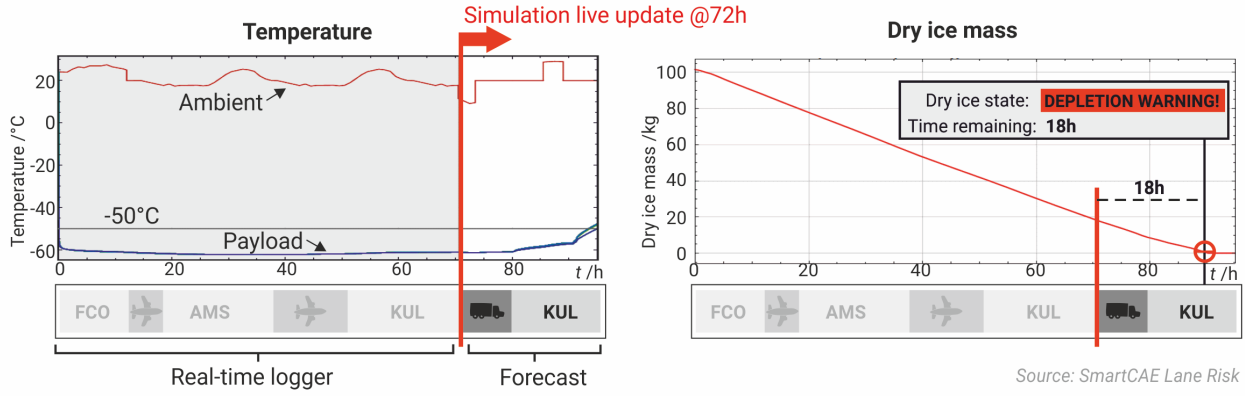
With the virtual lane risk approach it is possible to determine for each lane exactly how much dry ice is required, and at what points re-icing is necessary. This helps to reduce costs by determining the optimal protection – if a light container with little dry ice will do the job, it is not necessary to use an expensive high performance container. At the same time, the available payload volume is maximized by using only the amount of dry ice that is necessary, thus reducing needless excess.

Consider the example in the following figure: a simple container with 10 kg dry ice and payload on a lane of 40 h. If no re-icing is in place (a), the dry ice is depleted before arrival. A better container would be required. With standard re-icing (b), the container is refilled with dry ice after 14 h and arrives safely with 2 kg of dry ice left. But clearly, more dry ice was shipped than needed. With smart re-icing (c), only the required amount is initially loaded. It is then refilled after 14 h and arrives without temperature excursion. This way, at a limit of 200 kg dry ice per flight, 25 containers can be transported, instead of 20 without smart re-icing. For a 50L container, this results in a net increase of ~32% of transported payload per flight.



Predictive analytics

Virtual lane risk not only helps planning the delivery, it can also make a difference during the delivery. It can be coupled with real time temperature loggers, devices often used in today's shipments. This enables predictive analytics capabilities, empowering you to react to unplanned interruptions, such as flight delays. A dry ice depletion warning can be issued up to 20 h ahead, giving you enough time to put adequate re-icing strategies in place before the dry ice runs out.



Plan efficiently

Planning the upcoming dry ice shipments for COVID-19 vaccines on a short timescale is difficult and requires a good strategy. A virtual lane risk approach makes this feasible. It will help the airline industry manage the Herculean tasks ahead of us in the next months to overcome the COVID-19 pandemic.

References

[1] National Academies of Sciences, Engineering, and Medicine. 2013. *Technical Assessment of Dry Ice Limits on Aircraft*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22651.