

Optional cooling of green concrete with liquid nitrogen (LIN)

Task:

The solidification of concrete is an exothermal process. As large quantities of heat are released inside the concrete structure, it is very important that the temperature changes are monitored and influenced, in particular:

- in situations with high quality requirements for concrete (bridges, tunnels) storagetanks
- in cases requiring large volumes of concrete (dams, large foundations)
- in hot climates.

There are several factors that can cause heat accumulation inside the concrete structure with a high temperature gradient:

- hot aggregates caused by warm weather
- cement with a temperature of up to 70 °C
- hydration heat that is released in the chemical process during a period that is frequently longer than 2 weeks.

The cooling of the concrete after setting produces tensile stresses within the concrete structure which may result in the formation of cracks.

Solution:

To meet the high quality requirements for the use of green concrete, cooling with liquid nitrogen has proved to be an effective and cheap method. One particular advantage is that coolant costs are only incurred if cooling is really needed.

From a financial point of view, it is advisable to operate a conventional cooling system together with a nitrogen cooling system, with the latter being started up for "peak shaving" when the demand for cooling is particularly high.

Nitrogen cooling can be used in different ways when green concrete is being made:

- to cool the aggregates (larger than 8 mm)
- to cool the mixing water
- to cool the mobile mixer.

The use of the best cooling method for the specific task minimizes interruptions during production.

Ready-mixed concrete factory with cooling system during the construction of the Melk railway junction

- ① Control room
- ② Mixer
- ③ Inclined lift
- ④ Cooling container with cold air pipe
- ⑤ LIN storage tank
- ⑥ Lance cooling station
- ⑦ Aggregate silos



Advantages of cooling concrete with LIN:

The production of cooled green concrete with liquid nitrogen has many advantages for the user:

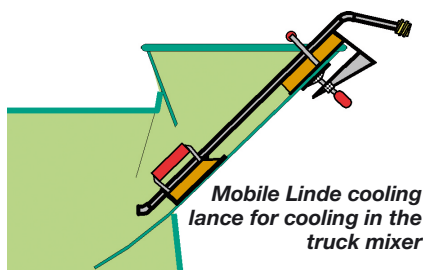
- low investment costs
- short lead times
- flexible cooling capacity
- different cooling methods to suit the production process
- simple operation and maintenance.

The coolant:

Liquid nitrogen (LIN) is a coolant that is obtained directly from the air and that can be kept at very low temperatures in insulated tanks with virtually no losses. Upon contact with the warm aggregates, the liquid nitrogen absorbs energy at the rate of 200 kJ/kg and evaporates in the process. The resulting cold gaseous nitrogen withdraws further heat from the material to be cooled at a rate of 150 kJ/kg.

Nitrogen is an inert gas that does not react chemically when it cools and that can be released directly into the atmosphere as a constituent of the air.

System components:



Lance cooling:

- Hand lance
- Control unit
- Frame with collision protection

Container cooling:

(Cooling mixing water and aggregates):

- Water tank with LIN heat exchanger (in the container)
- Fan with LIN supply system (in the container)
- Nitrogen installation with measuring and control equipment (in the container)
- Air pipe
- Nozzles in the aggregate silo.

A supply system for liquid nitrogen is essential for every cooling method. Such a system is usual an on-site tank system.

Technische Daten:

	Cooling lance/green concrete (values for 1 lance)	Cooling container / mixing water and aggregates
Concreting rate	24 m ³ / hour	40 m ³ / hour (cont. operation)
Cooling time	approx. 15 min / mixing vehicle	no delay
Staff requirements	1 person during cooling process	fully automated
Investment costs	low	higher
Lead time	ex-stock	ex-stock
Specific consumption	approx. 12 kg LIN / m ³ K	approx. 7-9 kg LIN / m ³ K

Concepts:

The **cooling lance** makes it possible very quickly and at low cost for the operator to maintain the required temperature values. Cooling is effected by supplying nitrogen directly into the filled truck mixer drum, the amount of LIN used is depending on the quantity of concrete and the degree of cooling to be achieved. Modification to vehicles is not necessary.

The **cooling container** was developed to ensure that construction sites are supplied continuously with high-quality, cooled green concrete. Special attention was also given to making best use of the cold nitrogen. Compared with the earlier method of direct injection of LIN, operating reliability has been increased enormously. Icing in the aggregate silo and blockades are now a thing of the past.

The mixing water is automatically cooled above the container to approx. 1 °C, which causes the temperature of the green concrete to drop by up to 3 K. By supplying temperature controlled air the aggregates (≥ 8 mm) are cooled down so that the temperature of the green concrete reaches the desired value.

Other leaflets about our complete range of applications and products are available in all sales offices.

Our experts are available for consultation.