

STEAM CURING

This document provides an overview of the volume of steam required for effective curing processes. It outlines the essential parameters that ensure optimal performance and efficiency during the process.

APPLICATION AREAS OF STEAM GENERATORS

Indications based on theoretical calculations and practical experience.

Steam temperature 100 °C / 1bar		Generator power kg / h										
		3	6	50	150	200	300	400	500	600	700	800
Necessary quantity of air (m <sup>3</sup> / min)		0,06	0,12	1,00	3,00	4,00	6,00	8,00	10,00	12,00	14,00	16,00
Necessary quantity of air (Liter / min)		60	120	1000	3000	4000	6000	8000	10000	12000	14000	16000
		m	m	m	m	m	m	m	m	m	m	m
DIAMETER (mm)	100	3,2	6,4	53	159	212	318	425	531	637	743	849
	125	2,5	5,1	42	127	170	255	340	425	510	594	679
	150	2,1	4,2	35	106	142	212	283	354	425	495	566
	200	1,6	3,2	27	80	106	159	212	265	316	372	425
	225	1,4	2,8	24	71	94	142	189	236	283	330	377
	250	1,3	2,5	21	64	85	127	170	212	255	297	340
	300	1,1	2,1	18	53	71	106	142	177	212	248	283
	350	0,9	1,8	15	45	61	91	121	152	182	212	243
	400	0,8	1,6	13	40	53	80	106	133	159	186	212
	450	0,7	1,4	12	35	47	71	94	118	142	165	189
	500	0,6	1,3	11	32	42	64	85	106	127	149	170
	550	0,6	1,2	10	29	39	58	77	97	116	135	15
	600	0,5	1,1	8,8	27	35	53	71	86	106	124	142
	650	0,5	1,0	8,2	24	33	49	65	82	98	114	131
	700	0,5	0,9	7,6	23	30	45	61	76	91	106	121
	800	0,4	0,8	6,6	20	27	40	53	66	80	93	106
	900	0,4	0,7	5,9	18	24	35	47	59	71	83	94
1000	0,3	0,6	5,3	16	21	32	42	53	64	74	85	
1100	0,3	0,6	4,8	14	19	29	39	48	58	68	77	
1200	0,3	0,5	4,4	13	18	27	35	44	53	62	71	

PICTURE 1

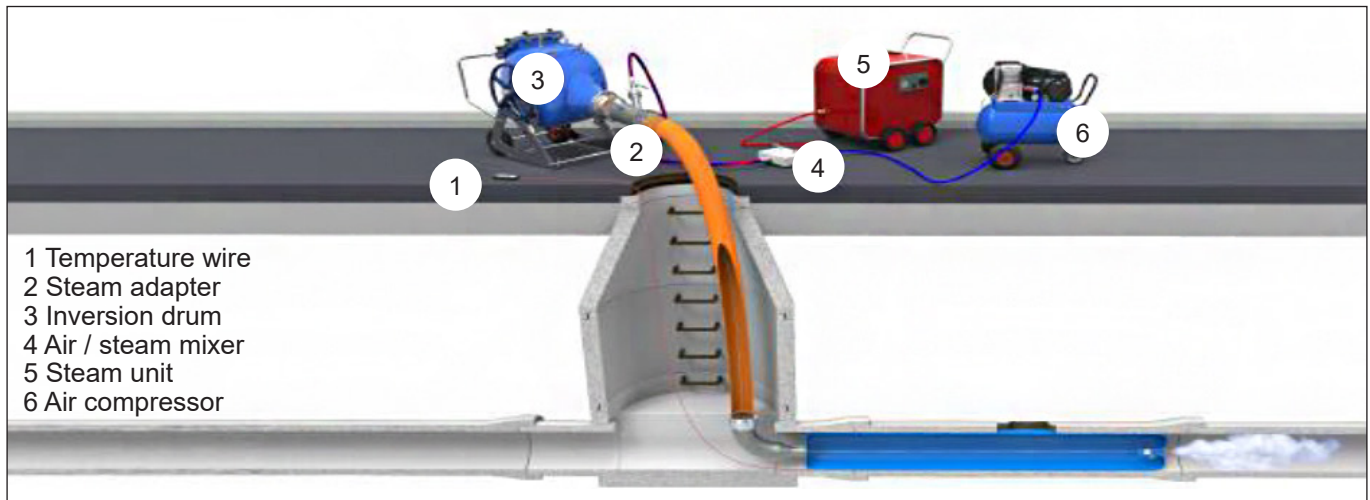
Steam volume required for 1 m<sup>2</sup> Liner surface = 3 kg / h

Air volume required for 1 kg / h steam = 0,02 m<sup>3</sup> / min

Regulating steam temperature presents challenges. To address these issues, we introduce cold air to facilitate the transportation of steam and to assist in temperature regulation.

The accompanying table (PICTURE 1) specifies the required air volume for this process. Essentially, when the exhaust valve is fully opened, the compressor must generate an adequate volume to supply the liner without adding steam, while concurrently sustaining the necessary curing pressure.

The configuration for steam curing is outlined as follows:



PICTURE 2  
Steam curing process

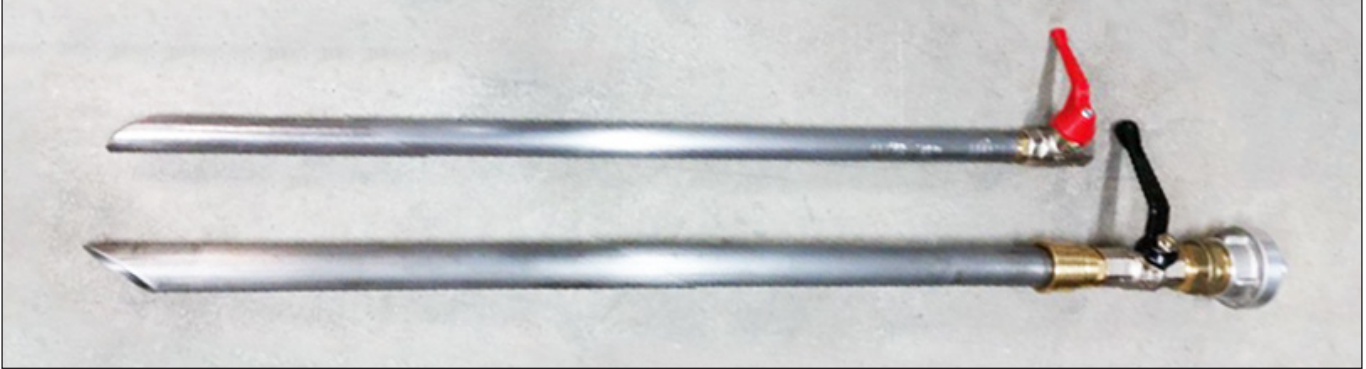
The steam outlet valve is placed at the end of the liner. The steam outlet has a Steam Pipe with a connection for a ball valve and hose.

The diameter of the steam outlet opening should meet or exceed the minimum specified diameter.

DN	mm
100	10 - 15
125	15
150	20
200	25
250	30
300	30 - 35
400	35 - 40
500	40 - 45
600	50

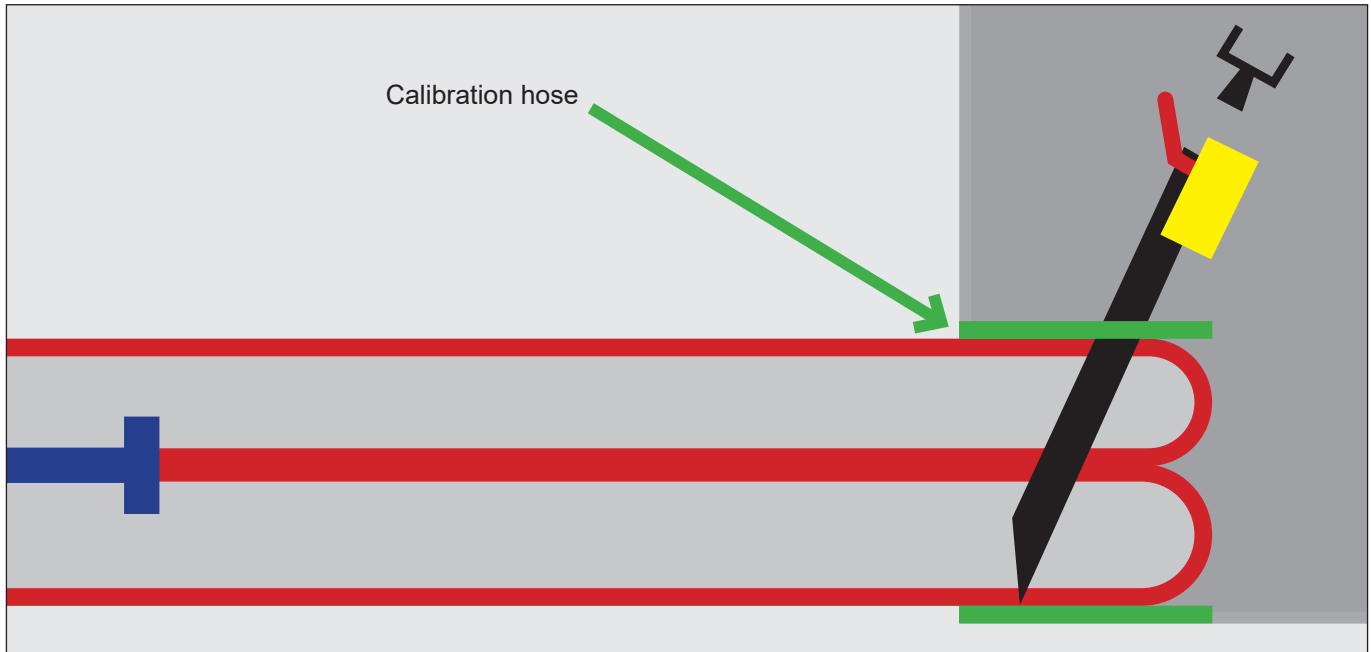
PICTURE 3  
Diameter vapor outlet

To effectively regulate the steam outlet, using a pipe with the appropriate diameter is essential. This can be connected either to a hose with a ball valve or directly to a ball valve. Refer to PICTURE 4 for guidance.



PICTURE 4

The Steam Pipe is pushed through the liner down to the bottom. Please refer to PICTURE 5 for clarification. Additionally, the steam outlet pipe also serves as the condensate outlet. Condensation can accumulate within the liner, adversely affecting its curing process.



PICTURE 5

## TEMPERATURE MEASUREMENT

The temperature is measured at the liner start point and possibly also at the end of the liner. For this purpose, a temperature gauge with measuring wire or an infrared thermometer must be used. The measuring wire should be inserted about 15 to 20 cm into the pipe. Temperature measurements must always be taken between the liner and the pipe wall.

## PROTECTION OF THE LINER

Using a steam-resistant heavy-duty calibration hose is essential to protect the liner from overstretching outside the pipe. Failing to do this may result in the liner bursting or causing unwanted vapor leakage.

## STEAM CURING PROCESS

To cure the liner, open the steam outlet to about 75%, supply cold compressed air, and maintain a uniform pressure at the specified curing pressure for each liner.

The process begins with the introduction of steam and a reduction in cold air intake while ensuring that the curing pressure remains stabilized.

As more steam is added, the need for cool air decreases. The heating phase should be gradual and must not exceed 60 °C. It's important to measure the temperature at 60 °C between the liner and the pipe wall, as this typically requires a vapor/air mixture at around 80 °C.

Continuously monitor and document the temperatures at all measurement points along the liner. If the temperature at the end of the liner is not rising as desired, it may be due to insufficient steam velocity to carry the heat to that endpoint. To address this, you should carefully open the steam outlet a little more.

Similarly, increase the amount of air from the compressor (cold air). To maintain the desired temperature, you will also need to increase the amount of steam while keeping the curing pressure constant. Ideally, the temperature measurements at both the start point and the end of the liner should be the same.

If the temperature at the liner end is higher than at the starting point, the flow rate is too high. To address this, slightly reduce the steam outlet and decrease the intake of steam and cold air accordingly. Maintain a temperature of 60 °C for about 15 to 20 minutes before increasing the temperature.

To reach the desired curing temperature, gradually increase the amount of steam while simultaneously reducing the intake of cold air. Follow the specific curing curves provided by the resin manufacturer.

Once the liner is fully cured, the cool-down phase begins. To initiate this phase, reduce the amount of steam and increase the cold airflow. Always maintain the appropriate curing pressure.

The cooling process should bring the liner down to the respective ambient temperature, which should then be maintained for about 20 minutes before reducing the pressure on the liner.

It is crucial to ensure that the condensate generated during the curing process can escape, as it is significantly colder than the surrounding area. If the condensate cannot drain properly, the curing time will be considerably extended. To allow for drainage, make a small cut at the lowest point of the liner.

If the pipe has a dent, the condensate will accumulate in that area, causing the curing process to be significantly slower than in other parts of the pipe. The curing time must be extended accordingly.