

<b>Rav number</b>	<b>BWL 2010.13.V7</b>	
<b>System name</b>	<b>Barn with air mixing system for drying the litter layer in combination with a heat exchanger</b>	
<b>Animal category</b>	<b>Broilers (E 5.11), (grand) parents of broilers in rearing (E 3.8), parents of broiler turkeys in rearing up to 6 weeks (F 1.7) and 6 to 30 weeks (F 2.7) and broiler turkeys (F 4.9)</b>	
<b>System description of January 2020</b>		
<b>replaces</b>	<b>BWL 2010.13.V6 of November 2017</b>	
<b>Working principle</b>	<p>Ammonia emission limitation is based on drying and heating the manure/litter layer by means of a maintenance-friendly heat exchanger in combination with:</p> <ul style="list-style-type: none"> <li>- continuously running circulation fans, or;</li> <li>- a height-adjustable divider system with animal-level tubes.</li> </ul> <p>With warm ventilation air from the stable, fresh air is heated in one or more heat exchangers.</p> <p>The heated fresh ventilation air is brought to the top of the ridge of the stable when using circulation fans. This air is then mixed with warm air at the top of the house by circulation fans and pushed to one or both ends of the house. The air is led back over the litter layer via the gable wall(s).</p> <p>When using distribution pipes, the heated fresh ventilation air is distributed evenly over the litter layer via a height-adjustable distribution system.</p> <p>By mixing the air in the house, an even temperature is achieved throughout the house. The manure/litter layer is dried and the carbon dioxide (CO<sub>2</sub>), other gases (including ammonia) and water vapor are removed from the animals.</p>	
<b>THE TECHNICAL EXECUTION OF THE SYSTEM; ARCHITECTURAL</b>		
	<b>Element</b>	<b>Execution requirement</b>
1	Stable floor design The	total stable floor construction, including any underlying sand layer, must be have a thermal resistance (R <sub>c</sub> value) of at least 0.5.
<b>THE TECHNICAL EXECUTION OF THE SYSTEM; TECHNICAL EQUIPMENT</b>		
	<b>Element</b>	<b>Execution requirement</b>
2	Housing form Complete litter floor	
3	Drinking water	Drinking water supply with anti-spill system
4a	Heating and air circulation system	<p>There must be at least one heat exchanger that heats fresh air for one or two houses. This air is mixed with the warm air present in the ridge of the house using circulation fans or evenly distributed over the bedding via a height-adjustable distributor system.</p> <p>Additional heating must be available to achieve the desired house temperature. This can be done in the stable as well as at the heat exchanger.</p>
4b	Heat exchanger Heat exchanger	<p>Heat exchanger(s) can be installed outside next to the house, or are placed inside the stable. The heat exchanger heats up freshly incoming ventilation air before it enters the house.</p> <p>The thermal efficiency of the exchanger is at least 70% for heat demand based on: <math>(T_{\text{inlet}} - T_{\text{outside}}) \times 100\%</math> (<math>T = \text{temperature}</math>)</p> $\frac{T_{\text{extraction}} - T_{\text{outside}}}{T_{\text{inlet}} - T_{\text{outside}}}$

4c		The minimum installed capacity of the heat exchanger(s) is 0.35 m <sup>3</sup> per animal place per hour (or a minimum of 8 m <sup>3</sup> per m <sup>2</sup> housing area) <sup>1</sup> .
4d	When using circulation fans	The air must be brought into the ridge of the stable. When the heat exchanger is installed outside the barn, this can be done by means of a pipe up to the ridge or by means of an inlet system with slats in the side wall and a air trap in the ridge of the barn. When using several heat exchangers distributed over the length of the house, the fresh air is blown out from the heat exchanger in the same direction as the air flow direction of the circulation fans.
4th		The circulation fans are placed at the top of the ridge of the barn at a mutual distance of a maximum of 20 meters and a maximum of 1.5 meters below the ridge of the barn. These circulation fans continuously keep the air movement going in the house.
4f		The minimum fan capacity of the circulation fans is at least 20 m <sup>3</sup> per m <sup>2</sup> of stable area.
4g	When using pipes	When using distribution pipes, the air must be distributed at animal level over the entire length of the barn.
4h		The air must be distributed via at least two rows of horizontally adjustable pipes that are suspended in the longitudinal direction. There is a proportional distribution of the pipes in the width of the barn
4i		The number of tubes is according to the supplier's specifications. The tubes are provided with holes on both sides. Distance, diameter and angle according to supplier's specifications.
5	Registration equipment	The following registration equipment must be present: - equipment for registering the heat exchanger on (hour counter); - equipment for recording the realized temperature curve, indoor, supply and outdoor temperature; - equipment for recording the realized ventilation flow rate in heat exchanger and fan capacity circulation fans
6	Capacity	Installation in existing stables: The capacity of the heat exchanger and additional heating to be installed is at least 125 Watt per m <sup>2</sup> at 35°C ambient temperature. Capacity according to supplier's specification  <u>New construction<sup>2</sup> :</u> The capacity of the heat exchanger and additional heating to be installed is at least 100 Watt per m <sup>2</sup> at 35°C ambient temperature. Capacity according to supplier.
<b>HOW TO USE THE SYSTEM</b>		
	<b>Element</b>	<b>Usage requirement</b>
a	living area	<u>In (grand)parents of broilers rearing up to 19 weeks:</u> _____ Minimum 900 cm <sup>2</sup> and maximum 1100 cm <sup>2</sup> per animal when set up (8.3 to 11.1 animals per m <sup>2</sup> ) <u>In parent stock of broiler turkeys reared up to 6 weeks:</u> _____

<sup>1</sup> For broilers, a production method can be applied in which chicks hatch from the egg in the barn and are then reared for a limited period in this barn. After the rearing period, the animals are transferred to follow-up housing. This production method, with the associated ages for transfers, is laid down in category E 5.9. Depending on the age of transfer, the ventilation requirement in the hatching/rearing house may be lower than the minimum capacity requested here. In that case, the installed capacity of the hatching/rearing house can be maintained.

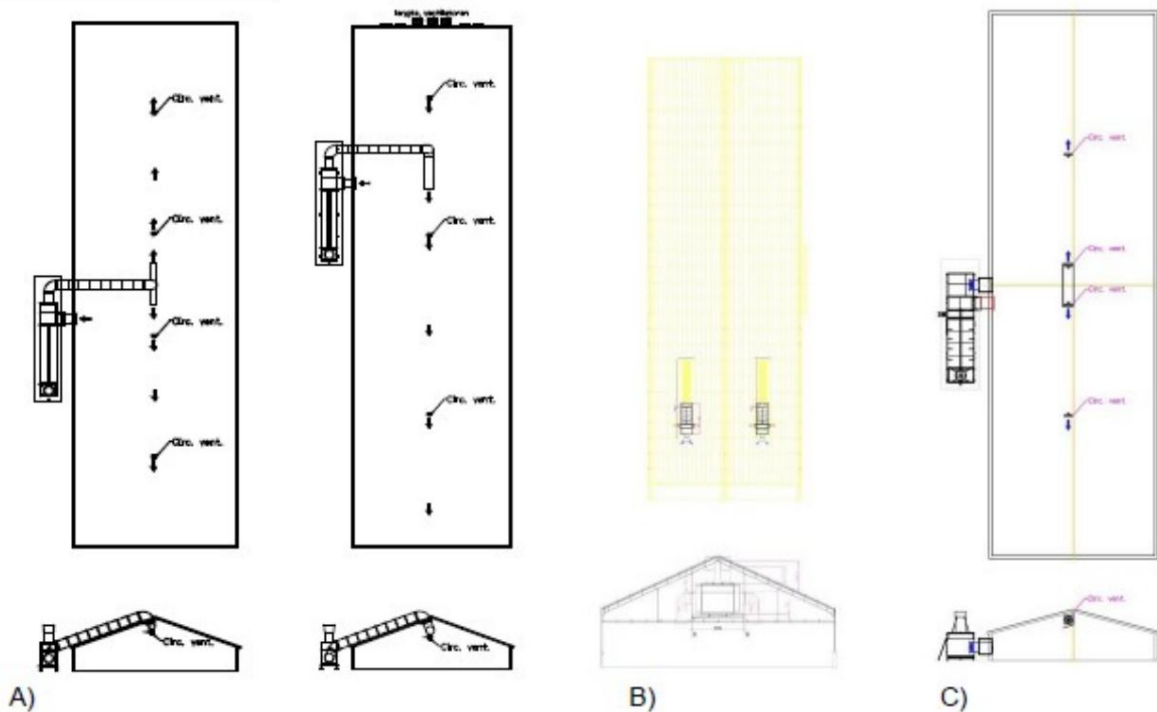
<sup>2</sup> 1 January 2000 is used as the date for 'new construction'. Stables built before that date must meet the requirement of existing stables.

		<p>At least 625 cm<sup>2</sup> per animal when set up (16 animals per m<sup>2</sup> )</p> <p><u>In parent stock of broiler turkeys reared up to 6-30 weeks:</u></p> <p>At least 1330 cm<sup>2</sup> per animal when set up (7.5 animals per m<sup>2</sup> )</p> <p><u>With meat turkeys:</u></p> <p>Males: Minimum 3330 cm<sup>2</sup> /animal at 10 weeks of age (3.0 animals per m<sup>2</sup> )</p> <p>Females: At least 2040 cm<sup>2</sup> /animal at 10 weeks of age (4.9 animals per m<sup>2</sup> )</p>
b1	Airflow when using circulation fans	The air in the upper part of the house <sup>3</sup> is guided downwards via circulation fans via the end facade(s) and is then blown evenly over the bedding surface.
b2	Airflow when using pipes	<p>The heated fresh ventilation air is evenly blown over the litter surface via the pipes on a height-adjustable distributor system.</p> <p>The height of the tubes is adjusted with the age curve of the animals ranging from a minimum of 50 cm to a maximum of 150 cm. During the cleaning of the stable, the pipes can be lifted up to the roof.</p>
c	Temperature curve setting	For at least the first 12 days of a round, the heat exchanger can provide the full minimum ventilation requirement of a house. During this period, the regular ventilation openings are closed and all ventilation air is extracted and supplied via the exchanger. The heating is switched on as there is a need for extra heat in the house, for this purpose the temperature curve is followed.
d	Fan setting in heat exchanger when it is heated	<p>The amount of exhaust air is measured with a measuring fan.</p> <p>The heating is switched on when the room temperature falls 0.5 °C below the temperature curve.</p> <p>The fan in the heat exchanger runs at minimum level when the animals are placed and will run 100% when the ventilation needs of the animals require it. The exhaust fan follows the supply ventilation curve.</p>
e	Setting the fan in the exchanger when there is no heating	<p>If there is no additional heat requirement and therefore no additional heating is required via the heat exchanger, the capacity may be regulated back to a maximum of 50% of the fan capacity.</p> <p>The exchanger may be switched off if the temperature difference between the set value of the house and the outside temperature is less than 12°C or if the animals are older than 4 weeks.</p>
f1	Setting when applying circulation fans	When the animals are placed, the circulation fans run at a minimum of 20% of the capacity for regular animals. With a lower occupancy from the start due to welfare requirements, the capacity can be adjusted in proportion to this occupancy <sup>4</sup> . The capacity is increased to 100% in proportion to the increase in barn ventilation.
f2	Setting when using pipes	<p>The aeration via the heat exchanger is started from day 1 and follows the minimum ventilation requirement of the animals from 10% to 100% of the capacity.</p> <p>After the maximum ventilation capacity of the heat exchanger has been reached, the inlet capacity must remain the same for the rest of the period.</p>
g	Registration	<p>For the purpose of checking the operation of the system, the following data must be automatically recorded:</p> <ul style="list-style-type: none"> <li>- switching on the heat exchanger and its fan(s);</li> <li>- the running of the circulation fans and the course of a round. This is to determine that sufficient drying air is continuously blown over the litter bed;</li> </ul>

<sup>3</sup> This concerns the air under the roof/ridge of the stable. The air is warmer there than elsewhere in the barn.

<sup>4</sup> Example: The capacity of 20 m<sup>3</sup>/m<sup>2</sup>/hour has been determined on the basis of the measurements at 24 broilers/ m<sup>2</sup>. At an occupancy of 15 animals/m<sup>2</sup> at set-up, the capacity can be reduced to 15/24 x 20% = 12.5% at minimum setting. Converted this is then 2.5 m<sup>3</sup>/m<sup>2</sup>/hour instead of 4 m<sup>3</sup>/m<sup>2</sup>/hour.

	- the temperature curve.
<b>Emission factor</b>	Broilers (including free-range and organic): _____ 0.021 kg NH <sub>3</sub> per animal place per year (Grand) parent stock of broilers in rearing up to 19 weeks: _____ 0.077 kg NH <sub>3</sub> per animal place per year Parent stock of broiler turkeys reared up to 6 weeks: _____ 0.05 kg NH <sub>3</sub> per animal place per year Parent stock of broiler turkeys reared up to 6-30 weeks: _____ 0.15 kg NH <sub>3</sub> per animal place per year Meat turkeys: _____ 0.21 kg NH <sub>3</sub> per animal place per year
<b>Reference measurement report</b>	Emission measurements in housing systems with Agro Clima Unit (ECN-E-10-087, Sep 2010) Updating ammonia emission factors for poultry; Recommendation for adjustment of ammonia emission factors for poultry in the Ammonia and Livestock Farming Regulation (Rav). Wageningen Livestock Research, Report 1015

**Sample drawings:**

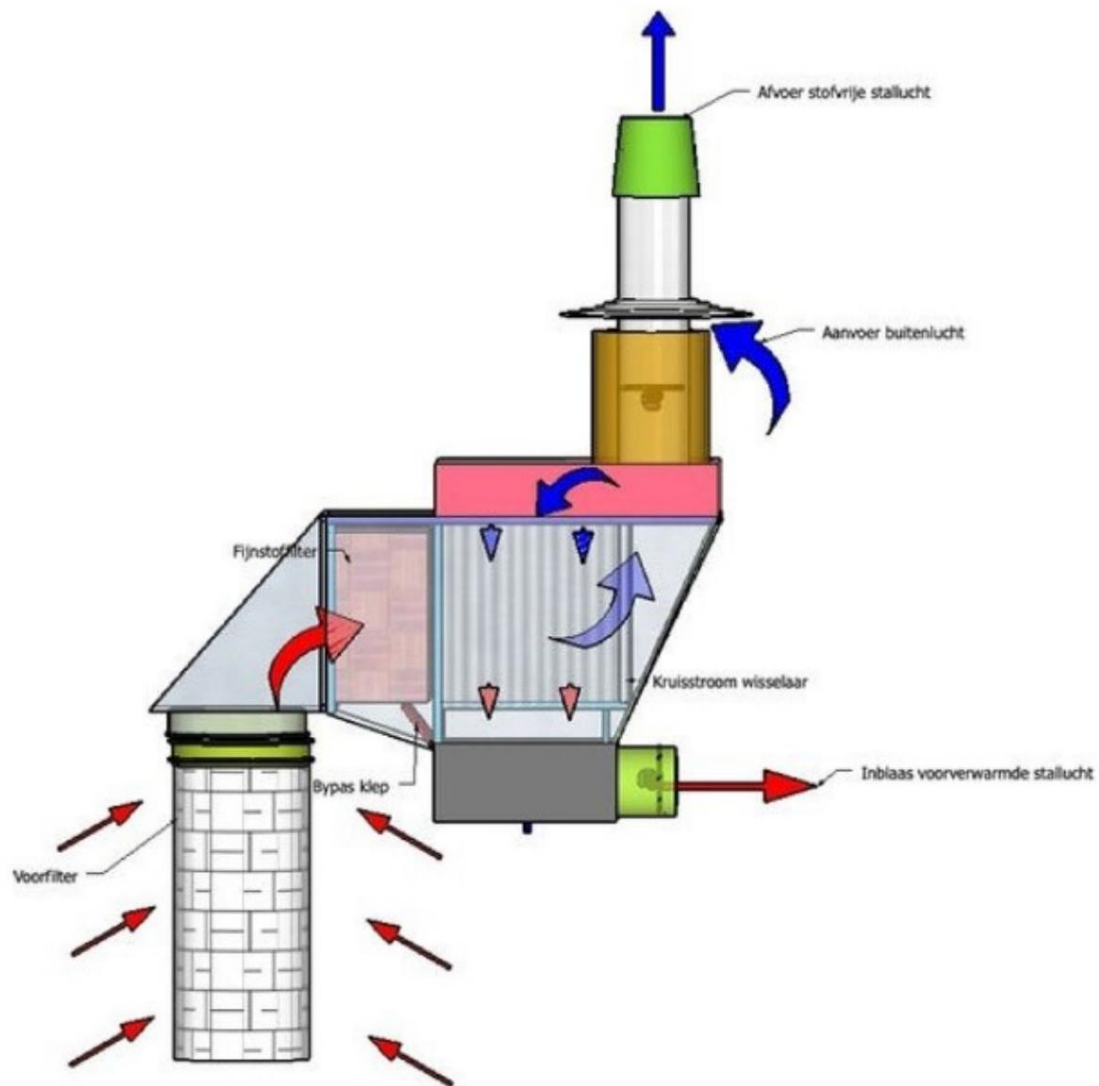
Floor plan and cross-section when using heat exchanger and circulation fans: A) placement of heat exchanger outside the house and introducing air via pipe to the ridge of the house (pipe can also be fitted on the inside of the roof).

B) placement of heat exchanger in the barn (number depends on required capacity).

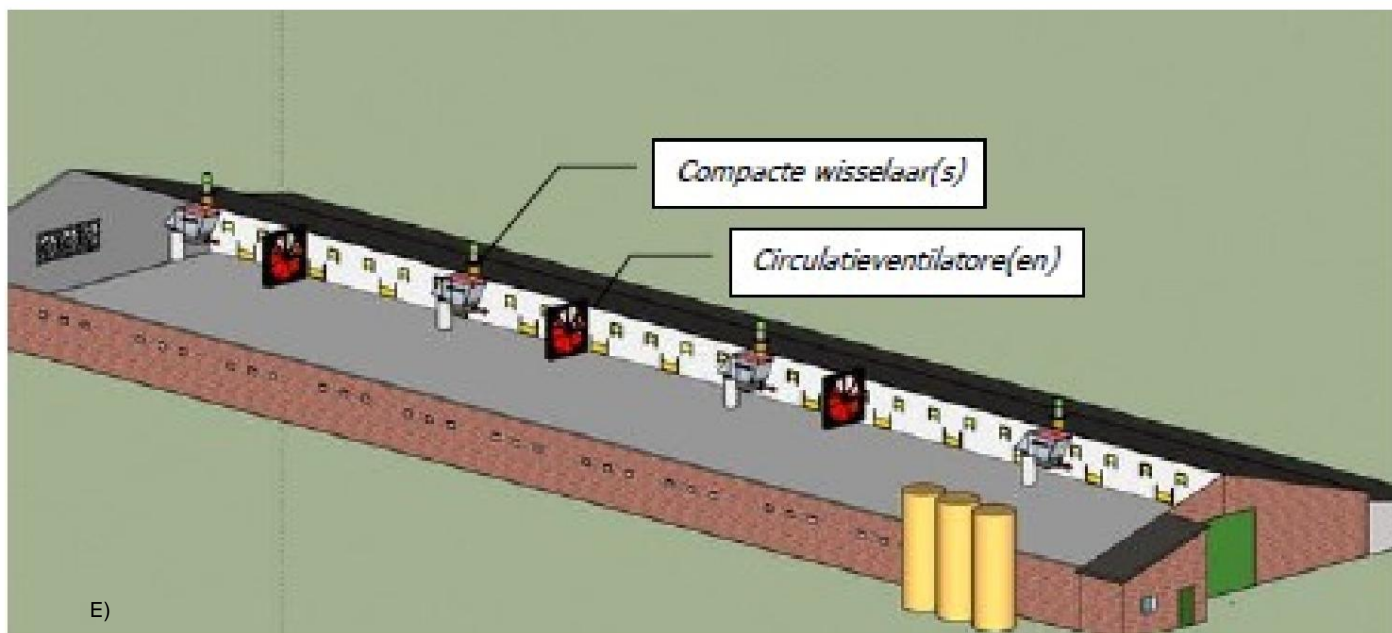
C) introducing air from the heat exchanger with fins in the side wall and collection in the ridge.



Example of slats (Louvre system) in the side wall and air collection in the ridge.

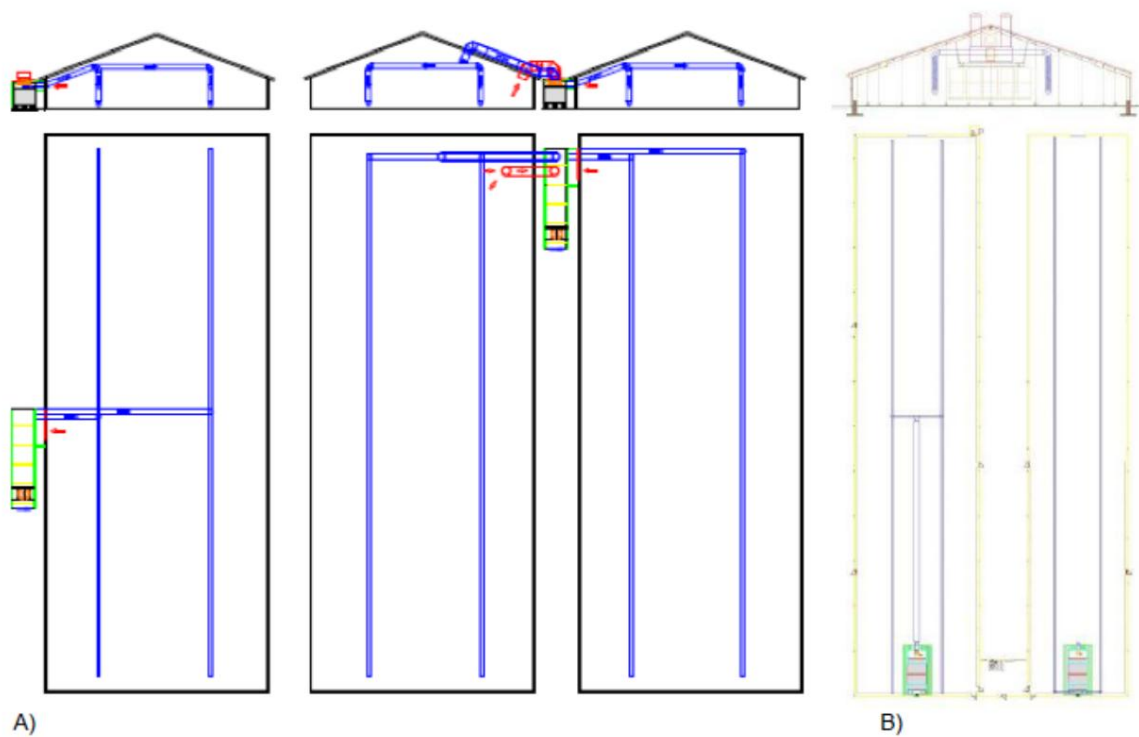


D)



E)

When using compact heat exchangers in the house with circulation fans:  
 D) principle sketch of compact heat exchanger with horizontal discharge.  
 E) image barn with compact heat exchangers and circulation fans.



Floor plan and cross section when using a heat exchanger with a tube system:

- A) placement of heat exchanger outside the house.
- B) placement of heat exchanger in the stable.

Name: Barn with	Number: BWL 2010.13.V7
air mixing system for drying the litter layer in combination with a heat exchanger	System description: January 2020