EXTENDED POSSIBILITIES OF USING WASTE HEAT FROM BIOGAS PLANTS THROUGH COOLING WITH ABSORPTION TECHNIQUE-RESULTS OF PILOT PLANTS AND ANALYSIS OF GREENHOUSE (CLIMATE HARMFUL) GAS EMISSIONS

Erweiterte Möglichkeiten der Abwärmenutzung aus Biogasanlagen durch Kühlung mit Absorptionskälte – Ergebnisse aus Pilotbetrieben und Analyse von klimarelevanten Gasemissionen

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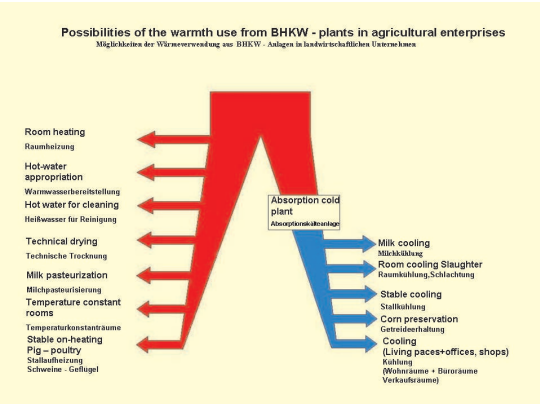
1. Level of the use of regenerative energies in Thuringia and the meaning of biogas plants of the farming

The safeguarding of the global economic development requires the stronger and stronger use of regenerative energies under the point of view of the prevention of a climate disaster. The industrial countries must be for the fast-developing nations like China, India and Brazil and ensure a reduction of the expulsion greenhouse gases exemplarily. Germany tries to fill out this pioneering role. In this the use of the biogas potential plays an important role (Abb.A1/A2). Expression for it is the amendment of the renewable energy law (EEG) as of 2009. The farming has a pivotal role at the possible biogas emerge with 85%.

About the fermentation of animal faeces an essential contribution to the issue reduction greenhouse gas also can be made. Since the use of the biogas is carried out via the electricity generation essentially in block-type thermal power stations (BHKW), the sensible use of the warmth of great economic interest attacking is.

The amendment of the EEG takes these into account with a cogeneration of power and heat bonus (KWK) of 2 cents bzw . 3 cents/kWh by the changed remuneration for the current from biogas among others with a NAWARO bonus of 7 cents/kWh, a slurry bonus of 4 cents (to 150 KW performance) or 1 Cent (for higher performance). The use of the KWK bonus requires intelligent solutions of the waste heat utilization into dependence of the different requirements in the course of the year. An improved warmth use in the course of the year only can be reached by a technical completion of the warmth use in summer by cooling processes.

(Appendix1)



2. Use of absorption cold aggregates into biogas plants as pilot plants one improved waste heat utilization in Thuringia

There is the problem of the waste heat utilization made of the engine cooling system and the waste gas of BHKW in summer at all biogas plants. Need coolers are used for a trouble-free operation. One of the few practicable variants of the warmth use consists in the transformation of the heat into cold waters by absorption cold plants. Under vacuum conditions a lithium Bromidlösung is made vaporize with the heat. At the following processes of the absorption and diversion of the solution warmth is withdrawn from circulations. Cold water is available for processes of cooling with 6° degrees Celsius at the end (Abb. A3/A4).

2.1. Use of an absorption cold plant for the milk cooling and the room cooling in the pig fattening in a animal Farmer

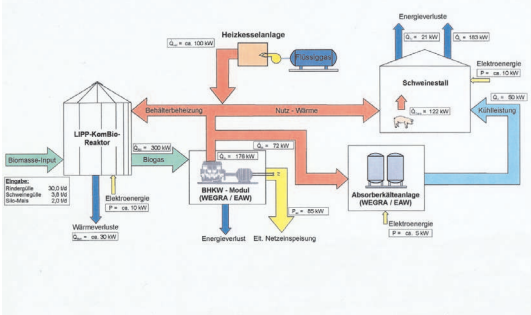
A biogas plant was installed with an electrical performance of 85 KW in 2004, meanwhile this plant have a performance from 360 KW. From the beginning of the biogas plant working ab absorptions-plant for cooling with the waste heat of power-engines by the biogas plant. The farm takes 220 milk-cows and 2000 porkers. The absorptions-plant is used for milk-cooling directly and air pretreatment of the pig fattening stable.

The fresh milk from the parlours from 35°C degrees is cooled down to 12,5°C, a compression-cold plant takes the rest cooling on 6-7°C until the collection.

The cold water is, used for the room air pretreatment in the mast compartments of the pig fattening stable in summer in which a maximum temperature of 25° degrees Celsius could be held in comparison with outside temperatures to 33°C.

In a comparison essay on a summer period with compartments of altogether 500 mast positions the cooling effect was examined.

(Appendix 2)



Results the pilot project's pig fattening stable cooling

Within the years 2004 and 2005 very respectable results were achieved in expensive comparison tests with 105 days each within the summer months. The functionality of the input air conditioning into the pig fattening compartments was proved by a continuous course measuring of temperature and humidity (Abb. A5/A6).The most important statement concerning it is that in the comparison of a chilled input air and management a difference in temperature of 35°C can be realized with bulk current in mast compartments and there were temperatures of 25 to 27°C in comparison with outside temperatures to 33° in the mast compartments (Abb. A7/A8). Mast compartments with pre-mixed air can be operated with lower bulk currents (reduction of the bulk current by 15%).

2.2. Use of an absorption cold plant of increased performance (140 kW of cold performance) in a milk cattle plant with milk cooling and room cooling in milking parlours and Pre-waiting areas for cows Sponsorship scheme of the Federal Institute of farming and diet

Already at the planning of a biogas plant with a performance of 500 KWel at the site of a milk cattle stable with 570 cows and absorption cold plant use for the milk cooling (14 tkg/day) and the room cooling in the milking parlours (2 x 16 Side by Side) provided in pre-waiting court. By a project promotion it was possible to install a refrigeration installation with 140 kW of performance what 185 kW of heat are used with. The project plan also made an extended direct use of the attacking BHKW warmth (calf milk pasteurization, warm-Water drinking off calfs and cows possible.

The milk cooling gets technical the cooling tanks preconnected more than two plate heat exchangers.

For the room cooling of the milking parlour and the pre-waiting court an air- water heat exchanger aggregate works in directly into the input air channels of the milking centre. This variant makes the heating in winter and the cooling possible with the same aggregate and control in summer.

The data acquisition of temperatures and humidity are carried out gas analysis via 9 measuring points, gas measuring installed tightly with a mobile Multigasanalyser at the same measuring points with tube supplying to this. The measurement results of the first annual season showed a good stabilization of the temperatures in the milking area of 20 - 23° at outside temperatures to -10°C in winter and maximum temperatures of 25°C at outside temperatures until the 33°C in summer. The results are shown in Abb. A7/A8. The air conditioning regulated automatically is very valued by the milking staff. The most important effect is the dry keeping of wall and ceiling areas by this ventilation way.

3. Pprotected results of use of absorption chiller units for these. Use of process warmth from the bio gas-production in the animal production

The warmth use is in climatic zones set no limits with clear differences in temperature in winter. This lets itself be seen with biogas plants in many sites, where processes of heating are protected.

The sensible warmth use is far more difficult in summer where only processes of cooling have an effect.

The result representation therefore refers to two summer time periods each, (2004/2005, 2008) air cooling running away from 105 days.

The economic calculations to the use of the proceedings are achieved with the animal performances, however, are always completed with a share from the warmth use about the EEG in Germany.

Unlike this, at the moment, positive environmental influences are not rewarded, in which the examinations for the issue reduction of greenhouse gases are oriented.

3.1. Economic use of the milk cooling under consideration of this one KWK bonus

The use at the milk cooling is obtained by the economy of cost of electricity at the use of compressor refrigeration plants. The energy for the cold water extraction is won from the BHKW cooling circuit; only a low electrical drive energy is necessary for pumps and compressors (3.5 KWel for 50 KWcold).

With the cold water from the absorber the milk cooles down from 34.5°C amounts of milk to 1100 kg/h from the 2 x 16 places milking parlour coming to 12 - 14°C.

The results represented in table 1 represent measurements for plant 1. No term results exist, but the results of the season elevations at single measurement days out of plant 2 yet.

Table 1. Profitability of the milk cooling

	Plant 1	**Plant 2**
Amount of milk/day	5 350 kg/day	14 600 kg/day
Milk cooling about absorbers	34.5°C	to 13.5° C cooled down
Cooling capacity/cold	130,4 kWh/day	356 kWh/day
*electricitycostsdegrease €/day	5,40	14,69
€/year	1 970 €	5 362 €
Deliver from KWK bonus	2 cents/ KWh_{el}	3 cents/ KWh_{el}
Working time absorber	9 Std.	11.5 Std. (with milk cooling)
Payment for KWK-Bonus/year	**4 890 €**	**22 283 €**

* Saving only from electricity expenses, without charge of longer term, less servicing of her Compressor cooling.

From this analysis gets clear, that at a technical realization of the complete milk cooling no more compressor cooling is necessary (passive cooling store tanks). This can be realized only with an iced water plant at present, which one the cooling of the milk on the storage temperature of 6° Ceius to 7° takes on.

3.2. Room air conditioning in the keeping of animals Prevention of heat-stress and evaluation of the economic success

For the economically meaningful species of animals cattle, porks and poultry the optimal temperature ranges are noted for the performance exhaustion. You always are animal species-specific and lead at differently high summer temperatures to performance depressions. In extreme cases losses have to be mourned such as with poultry in the temperature range from+27°C to+30°C without cooling phases.

The mast performance was examined in the mast compartments by pigs into dependence of the input air temperature in our test installations. Further expensive tests to the influence of the temperatures on the milk yield with cows and the fertility event are in processing; of the influence at the sow keeping there already exist results.

The results represented in table 2 produced the evaluation of the results in the pig fattening

60 g increase daily increase over a period of 105 days of approx. .

Table 2. Tierleistungen – Masttagszunahmen
(animal performance – test day growth)

Comparison of the animal performance in the cooled (attempt) and not cooled (comparison) to pork mast compartments

	attempt	comparison
evaluated fattened pigs (piece)	252	271
average day increased (g/day)	778	721
average carcass weights (kg)	95,4 – 104,2	93,4 – 101,5

These results found out in the operational situation can be used for the calculation of the economic profit.

Under the prerequisites of the test mode I the result looks as follows:

Increase of the daily increase 721 g/day to 778 g/ day = mast time shortening from 127 to 118 mast days for 900 places at costs of 55 cents/mast day and positions

An economic result = 4 455 €/summer season

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+ payment from KWK bonus from term prolongation of the absorber of 9 Std. (milking time) to 22 h/day on 105 days/a = 2 048 €

With the complete use of 8 908 €/a a period of redemption of 6 to 7 years is reached for the absorbtion-plant in completion of a biogas plant, positive side-effects co-not judged economically are (improved health of the animals, environmental effects by less harmful gas issues (climate protection) and resource security).

4. Environmental effects by the reduction of greenhouse gases

The determination of the climate harmful gas issues from the animal production requires a direct concentration measurement at the issue place in stable (run and couch area) and the determination of the air flow volume. This was realized by automatic taking gas-volume about days in the pilot plants, in which you can measure with a multi-gas Analyser NH_3, N_2O, CO_2 and H_2S. The evaluations are aligned with the NH_3 concentration in correspondence with CO_2.

The emission rates of NH3 from the pig fattening tests arranged which were measured at compartment temperature differences of 2 to 3° degrees Celsius are in table 3

Table 3. Ammoniakemissionen – Emissionstraten (rates os emission)

measurment from 03.09.04 – 11.09.04	Unit	chilled compartment t_{VU}= 24,3 °C	not chilled compartment t_{VU}= 26,2 °C
NH_3 - emissionrate	g/ h and compartment	60,44	73,50
NH_3 - emissionrate	kg/ animalplace in 70 days[1]	0,35	0,43

[1]...calculation (chilled days in the stable in 2004 with outdoor temperature > 24°C)

An input air conditioning leads to the reduction in the emission rates by 15 to 21% in the summer months which corresponds to a reduction in the course of the year by 10%

The results (NH_3) in same with results from BÜSCHER et al 1996.

The determination of the greenhouses gas issues in the keeping of cattle is considerably more expensively and only in locked areas practicable not in open-ventilationsystems. Measerement in our case a realised in pre waiting area of the cows, milking parlour.

Series of measurements to this are completed to 2010.

With an CO_2-equivalent from 16 from NH_3 in all species of animal and her production stables can be made an essential contribution to the environmental protection through the significant reduction of greenhousee gases.

The results are shown tooin Table A 9.

5. Main emphases of one enlarged use of processes of cooling in the agricultural one Area

The installation of an absorption aggregate for the use of the waste heat of a biogas plant causes additional investments which a multiple exploitation of the cooling potential requires for its amortization. Ideal is a continuous cooling as in the case of the milk with an additional cooling variant in summer. This can be reached by room cooling best. Further technical prooftesting of room cooling variants operated devotedly himself through into animal product ion:

- Cooling in areas-in the picled-production and sow keeping (nursing stable, insemination area)
- Heat dissipation at the poultry keeping in summer (cooling-systems at floor keeping about underfloor heating-cooling-cooling of store
- healthy preservation of harvester-grain particularly at an operational treatment with cooling
- Room cooling variants and use variants in office and dwellings at the site of agricultural biogas plants.

The prooftesting of such technical systems requires additional charges for room technology and measuring and control engineering, therefore investment supports are necessary about promotional programmes; this applies to the first application particularly.