EDITORIAL

Human warmth

Everybody radiates heat. Depending on whether we are resting or moving about, each and every one of us emits between 70 and 100 kilowatts. It is this heat generated by people that researchers have put to good use in the project "Houses without heating". Together with the heat given off by household appliances and received from insolation, it is absolutely adequate for the houses now being built in Sweden. But, of course, these are extremely well insulated and exceptionally well constructed houses. And they are not in the north of Sweden. Read more about how this is achieved in the first article in this issue.

How are the environmental properties of a building measured and evaluated? Today there are many methods, but they are often company specific and not very easy to follow. What is needed is a generally accepted, open method that is based on scientific foundations. The Swedish Council for Building Research is in the process of developing such a method. This is described on p. 10.

The article on 20th century Swedish architecture gives only a tiny foretaste of the splendid book it refers to – a really magnificent book (in English), full of well informed articles, and copiously illustrated.

Kerstin Franklin
Editor

IN THIS ISSUE

Cover: The architect Erik Asmussen, who died just a few weeks ago, designed the blue buildings of the anthroposophists in Järna, to the south of Stockholm. He is one of the internationally known architects who is presented in the book "20th Century Architecture: Sweden" (See the back page). Photograph: Claes Caldenby

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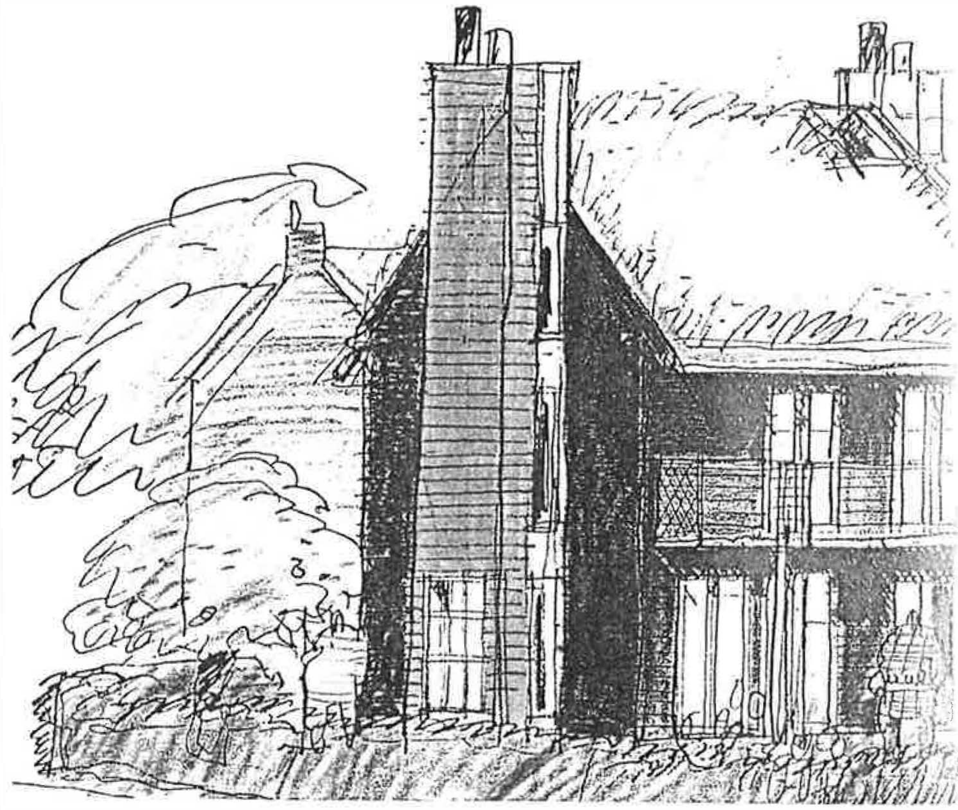
No heating

A house without a heating system in our cold climate – is it possible? In each of Göteborg, Malmö and possibly also in Hannover, about 20 terrace houses which are so energy efficient that they need no special system for heating are under construction. The Swedish Council for Building Research (BFR) is providing financial assistance.



The same kind of terrace houses are built in Göteborg, Malmö and Hannover. The houses manage without any heating system at all, owing to the fact that they are very airtight and have very thick insulation, the windows are extremely good, and all electrical appliances and all lighting is energy efficient. The technology is not new, but very well applied. Sketch by Hans Grönlund, EFEM.

The project "Houses without heating" involves close collaboration between research and the construction industry. The intention is to demonstrate known technology, applied in a new way. By providing good insulation, minimising heat losses from ventilation air, water and waste water, and utilising heat gains from occupants, heat from household appliances and lighting, and solar heat, it is possible to build houses with a good standard of indoor comfort without a heating system.

The project forms part of an EU project "Cost Effective Passive Housing for European Standards (CEPHEUS)" which comprises parallel projects in some European countries, all supported by the EU THERMIE Programme.

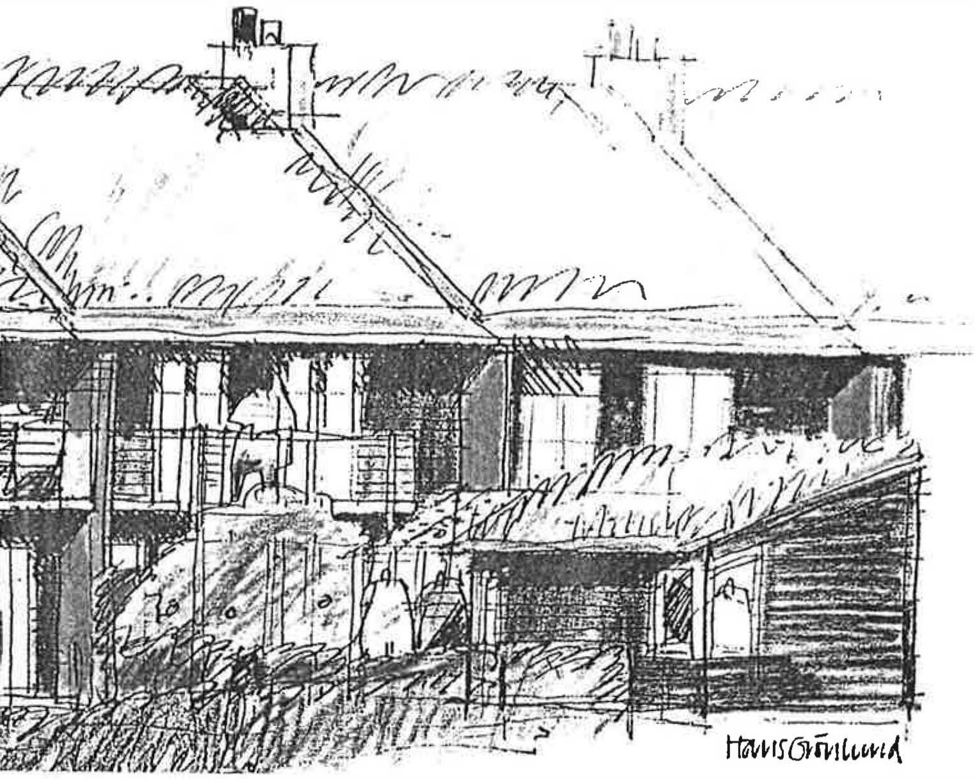
The houses will be built at Lindås in South Askim in Göteborg, in the north harbour in the area for the housing exhibition BO 2001 in Malmö, and possibly in Hannover; twenty houses on each site.

Swedish know-how and Swedish-German r&d cooperation

The technology of utilising passive solar heating, i.e. planning houses in such a way that incident solar energy

at all? – Is it possible in Swedish climate?

By Hans Eek



and adventitious heat gains make an essential contribution to the heating of the houses, was developed in the 70s. It is a prerequisite for this technology that heat losses from the houses should be small, i.e. that they should be well insulated and airtight.

In Sweden, we have built houses of good energy standard for a long time. Swedish construction technology has attracted international attention, for instance in Germany. In the project "Ingolstadt-Halmstad", a building research cooperative venture between the two countries in the 80s, it was shown, for instance, that application of Swedish building technology could reduce heating energy to one third of that in newly constructed German houses.

These principles have been developed in Germany, and five years ago a row of terrace houses which require no energy at all for heating were built in Darmstadt-Kranichstein. The experiences gained in these projects will now be applied in Hannover in building "houses without heating systems". The intention of our BFR project is to develop further the underlying principles for Swedish conditions. After all, Göteborg and Malmö are on a different latitude from Hannover!

In Göteborg, Malmö and Hannover also the houses will be almost identical. They are two storey terrace houses with attics, designed by *Hans Grönlund*, EFEM arkitektkontor. Terrace houses have small surface area in relation to the floor space and heat losses are therefore low. The entrance is from the north via a glazed porch. On the south side there are large windows to utilise passive solar heat.

The houses are relatively deep, ca 11 m. To provide daylight in the centre there is a light well with a roof light. The horizontal panels are painted with dark distemper and red Falu paint. The roof is a planted with stonecrop(*sedum*).

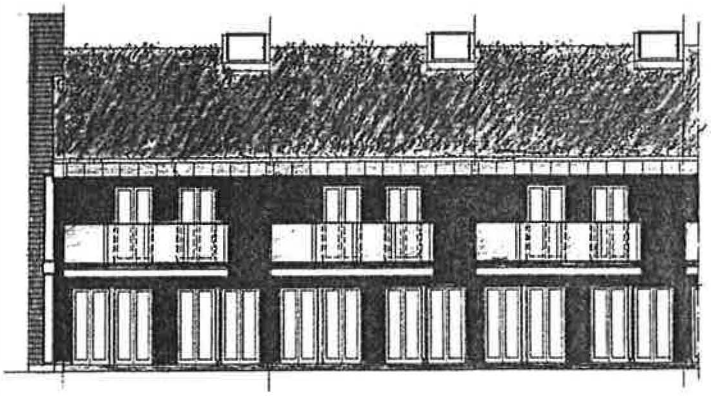
Very thick insulation

The intention of the technoogy is to minimise heat losses and to utilise the small internal heat which is available in the winter.

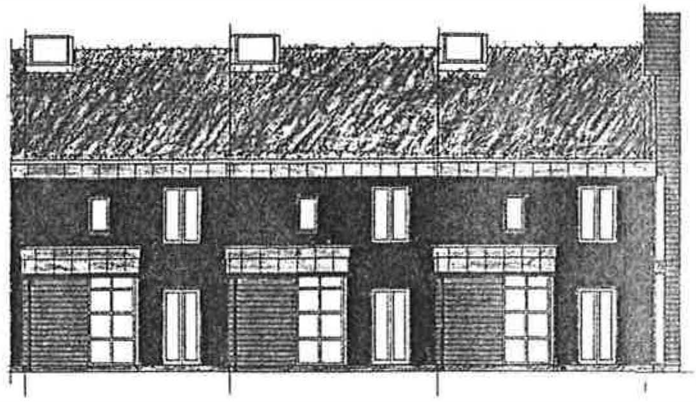
The houses are built on a concrete ground slab underlain by insulation. The loadbearing frame is a lightweight timber construction with very few thermal bridges and very thick insulation (35 cm in the walls,

Activity	(kWh/year)	Proportion returned to the house in the form of "adventitious energy"
Storage of food	457	100%
Cooking	568	30%
Washing up	250	20%
Laundry	271	20%
Drying	350	100%
Lighting	300	100%
Others	574	100%
Total	2 770	

This is the energy needed for some usual activities in a house TABLE: LI LÖVEHED



The courtyard facade to the south has large windows right down to floor level. Eaves and balconies act as sun screens.



The entrance facade to the north has fewer and smaller windows. The door is protected by a glazed porch.

50 cm in the roof). Fabric losses through the building envelope are small; see the table.

The windows are extremely good. With a U value of 0.85 W/m²K and a luminous transmittance > 65%, they provide an energy increment on even the coldest days in winter.

Great care needed

Leakage of heat is limited by an airtight layer. The requirement is 0.5 ach at a negative pressure of 50 Pa, which is equivalent to an opening the size of a hand in a house. This is achieved only by great care in design and workmanship of painstaking accuracy.

Ventilation is about 0.5 ach. It is open to doubt whether this air change rate, determined for Sweden, is relevant. In Germany and other countries which are taking part in the CEPHEUS project, a lower level has been chosen: 0.2 ach when the house is unoccupied and 0.5 ach when there are people in the house. A lower air change rate gives greater freedom in designing the ventilation system.

The ventilation system consists of mechanical supply and extract ventilation with a heat exchanger of 90% temperature efficiency. The heat exchanger can be turned off in the summer and the house can be ventilated using only extract ventilation and window opening.

Supply air through the ground

Supply air for the houses may be heated in a buried duct. Experiences from Darmstadt show a constant supply air temperature, 8–10°C and no difficulties due to dust or mould. In our climate, however, there is an evident risk of this as shown by investigations. The project includes investigation of problems due to buried supply air ducts.

The energy balance of the houses over the year is not appreciably affected by their heat storage capacity. However, a heavy structure has the effect of damping temperature fluctuations over the day. Our houses have a light frame. Walls and ceilings are lined with plasterboard. The capacity to store heat is important in damping temperature fluctuations between day and night in the event of cold snaps, but we consider that the storage capacity of the building materials is adequate since the houses are well insulated and require very little additional heat input in the event of any cold snaps. This will be simulated in the research project.

Energy efficient electrical appliances and lighting

In the project we have assumed that the most energy efficient electrical appliances available in the market will be used by the households. Apart from household electricity, power is needed for the ventilation plant and for the pumps in the solar collector installation.

Energy – hot water and electricity

The energy supplied is hot water energy and electrical energy. In Hannover the houses will receive their domestic hot water via the district heating system, and the house purchase there includes shares in a wind power plant corresponding to the need for electrical energy supply. In Malmö the supply of external energy is still an open question. Göteborg Energi is involved in energy supply to the Lindås estate. Apart from solar heated domestic hot water, a small cogeneration plant with a biofuel driven Stirling engine, for all the buildings, may be installed.

Heat from occupants

The amount of heat from occupants is based on the assumption that a family of 4 persons is at home for an average 17 hours per day from September until May and for 8.5 hours per day from June to August. This represents an increment of 1012 kWh during September-May and 170 kWh during June-August, i.e. a total energy increment of 1182 kWh over the year. Each person generates 70–100 kWh depending on whether he/she is moving about or resting.

Energy savings pay for the extra cost

Construction costs are estimated to be "normal". The extra costs due to additional airtightness and insulation, modifications for passive solar heat and recovery of heat from ventilation air are financed through the considerably lower costs of the heating system and the savings in energy costs.

The houses are neither more nor less complicated than ordinary houses, and anybody can live in them. Obviously, houses without a heating system impose behavioural demands on those living in them, but there is no need for complicated manuals, sound common sense is sufficient.

What if it is –20°C over a long period?

In the course of the research project, indoor climate at various extreme outdoor temperatures will be simulated. Experience shows that a well insulated and airtight building is less sensitive to variations in the outdoor

U values of parts of the building:

External wall: 0.10 W/m²K
Double stud wall with 35 cm insulation

Roof: 0.08 W/m²K
Masonite beams with 50 cm insulation

Floor: 0.13 W/m²K
Concrete slab underlain by 20 cm insulation

Windows: 0.85 W/m²K
Triple glazed with two metallic coats and krypton fill. 50% energy transmittance. Luminous transmittance > 65%

External door: 0.80 W/m²K

Ventilation:
Supply and extract ventilation with heat recovery. Counterflow heat exchanger of 90% temperature efficiency. Preheating of supply air in buried duct. Sound level max 25 dB(A).

Energy recovery in a normal year:

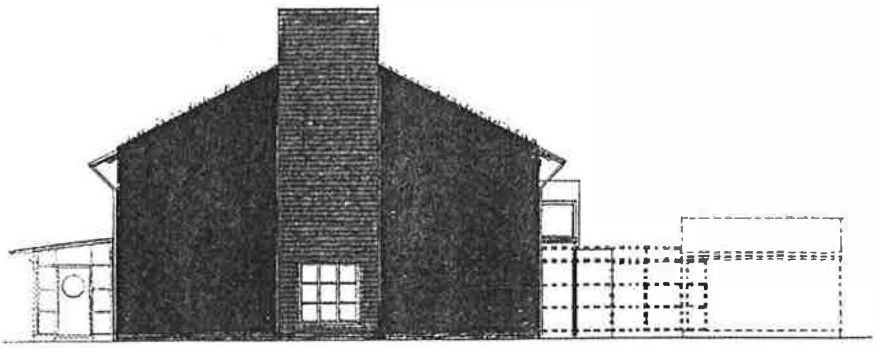
Domestic hot water	3,000 kWh
– of which solar heat	1,500 kWh
Heating load	125 kWh
Household electricity	2,270 kWh
Electricity for services	215 kWh
Total energy supply	**4,610 kWh**

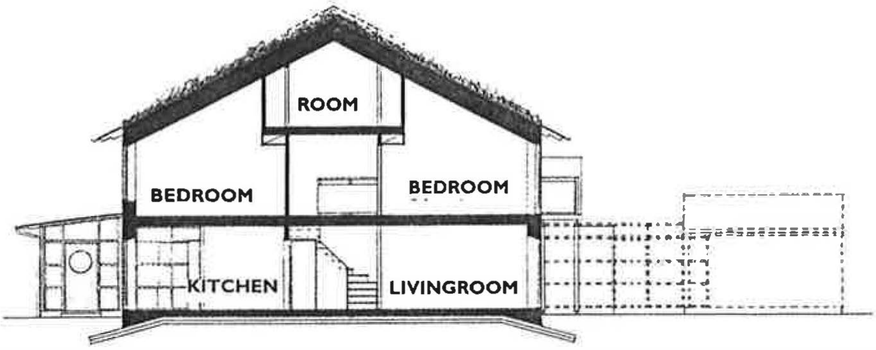
climate than an ordinary building. The house is designed and constructed for normal climatic conditions. Low outdoor temperatures over long periods are rare and are considered extreme conditions. In such cases temporary solutions must be employed, for instance putting on more clothes or lighting a bunch of candles. Or switching on a low power heater of some kind.

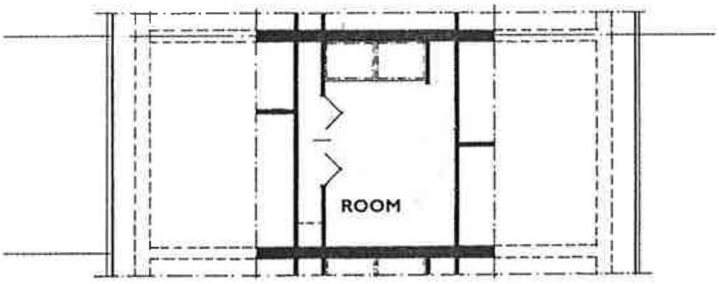
No traditional research project

The project is not a research project in the traditional sense, since it does not in actual fact comprise research and development of new technology. The construction technology is very simple and well tried and tested. Technology for the supply of services is available in the market. What is unique in this project is that well developed and tried technology is developed into a holistic solution which produces a building that is very energy efficient overall, has reasonable costs and a good standard of comfort.

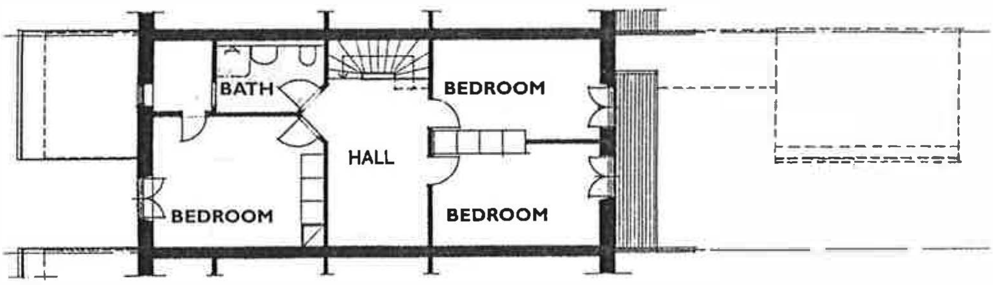
The research project does however include an untested part, and this is the collaboration between researchers, designers, constructors



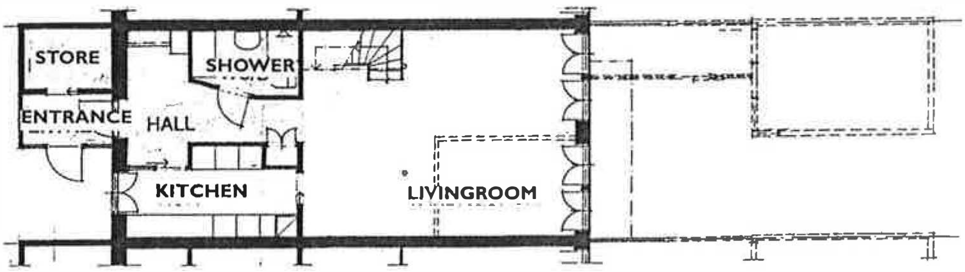




Garret



First floor



Ground floor

and clients. Problems and solutions are in closer contact, and it is hoped that this will also make for greater understanding between the different parties in the construction process and between universities/research and the industry.

Research areas

The *Swedish Testing and Research Institute, SP*, deals with specifications, solar heat, heat exchangers, measurements and evaluation (Svein Ruud).

Building Physics, Chalmers University of Technology, investigates the problems associated with, the buried supply air duct (Carl-Eric Hagentoft).

Building Science, University of Lund Institute of Technology, performs computer simulations of indoor climate using the DEROB-LTH program, researches into aspects to do with thermal bridges, the properties of windows and the need for solar control, as well as the ventilation system and heat exchanger, and energy efficient electrical appliances (Bertil Fredlund and Maria Wall). ■

The following are participating in the project "Houses without heating":
Client in Göteborg: Egnahemsbolaget
Client in Malmö: HSB or PEAB
Client in Hannover: Rasch und Partner
Turnkey contractor: PEAB
Architect: EFEM arkitektkontor, Göteborg
Designer: KM, Göteborg
Mechanical services consultant:
Bengt Dahlgren AB, Göteborg
Electrical consultant: Probeko, Göteborg
Landscaping consultant: Landskapsgruppen, Göteborg.

Hans Eek, Architect SAR, EFEM arkitektkontor, Göteborg, is project manager.
Tel +46 31-17 84 60,
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Information concerning the project "Houses without heating" can be obtained from the author or **Conny Rolén**, Senior Research Officer, BFR,
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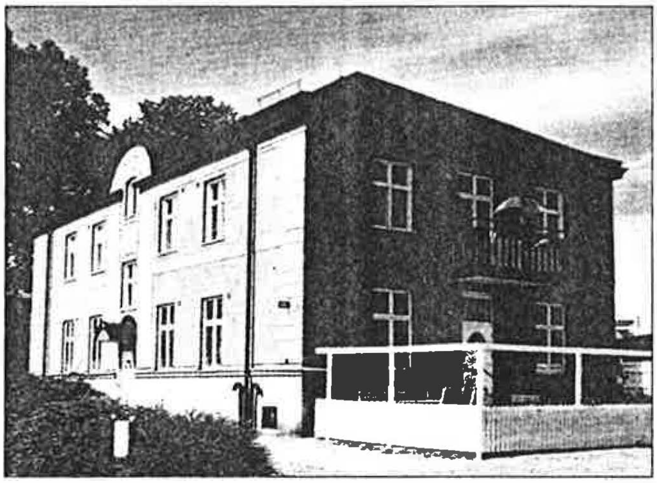
Cuts in defence result in sale of barracks



The guard room was converted into housing when the infantry regiment at Örebro was disbanded.

Reuse of defence real estate
(in Swedish)
Ragnvi Josefsson,
Ulf Ranhagen

As a result of cuts and effectivisation in Swedish Defence, almost one half of the ca 100 establishments constructed over the past 100 years have so far been closed down, and this trend is expected to continue. Most of the barracks buildings have found new uses, the type of use being largely governed by their location. A survey of the process from closure to new use shows however that there are shortcomings in the planning of land and building resources. By examining what significance various factors have for the result, an understanding can be gained of the scope provided by the buildings of a disbanded regiment.

Report I (ISBN 91-630-5573-2) and Report II (ISBN 91-630-5247-4), VBB Samhällsbyggnad, Birgitta Andersson,
tel +46 8-695 60 00,
fax +46 8-695 64 70.

Invest in good refrigerants

Zeotropic refrigerant mixtures in systems and in flow boiling
(in English)
Peter Rohlin

The need to replace freons (CFC and HCFC compounds) as refrigerants in refrigeration and heat pump plants has created interest in mixtures of different environmental substances. Most mixtures are zeotropic, i.e. they boil and/or condense as the temperature changes. Zeotropic refrigerants may cause certain problems which are discussed in this doctoral thesis.

Doctoral thesis TRITA REFR 96/19 (English), Energy Technology, KTH, tel +46 8-790 74 51, fax +46 8-20 30 07 (210 pp, SEK 250). ISSN 1102-0245.

Flow condensation of refrigerants and refrigerant mixtures
(in English)
Wei Shao

Condensation in pure substances and mixtures of pure substances used as refrigerants in refrigeration and heat pump systems has been studied.

The effect of oil admixture into the refrigerants has also been analysed, both theoretically and experimentally. The investigations show that the effect of oil can generally be ignored. The thesis explains this by demonstrating that two counteracting phenomena occur and largely cancel out each other.

Doctoral thesis TRITA REFR 96/18, Energy Technology, KTH, tel +46 8-790 74 51, fax +46 8-20 30 07 (187 pp, SEK 250). ISSN 1102-0245

Evaluation of zeotropic refrigerant mixtures R32/R134a in flow condensation, (English) Wai Shao, Eric Granryd. Article in AES Vol 37, Proceedings of the ASME Advanced Energy Systems Division, ASME 1997.

Market assessment of thermally activated heat pumps in Sweden and heat mass transfer enhancement in absorption cycles, (English) Magnus Gustafsson. Licentiate thesis TRITA-KET R78, Chemical Technology, KTH, tel +46 8-790 60 00, fax +46 8-790 65 00 (117 pp). ISSN 1104-3466