RECYCLING OF FLAME RETARDANTS OF FLEXIBLE POLYURETHANE FOAM *VIA* GLYCOLYSIS

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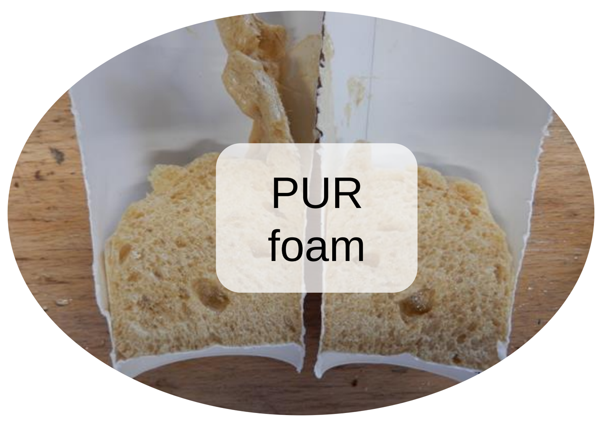
Introduction

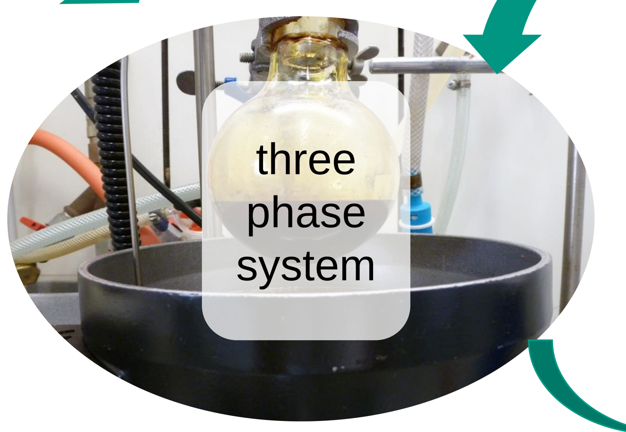
The polymer market, its demand and production are constantly expanding. Nowadays, polyurethanes are important polymers with moderate market share. However, the growth in 2013 reached 5,9 % (production 19 mio. tons) and 6,8 % is expected for 2014. One of its most known applications is the use as a flexible foam for matrasses and cushions (around 25%). Due to their surface structure these materials are easily ignited and need to be protected with FR. The recycling of PUR through glycolysis is widely known and already used in the industry. The focus of the recycling of PUR has been always aimed on the polyol recovery. This work will concern the flame retardants which are used to protect a flexible PUR foam in regard of their recyclability *via* glycolysis.

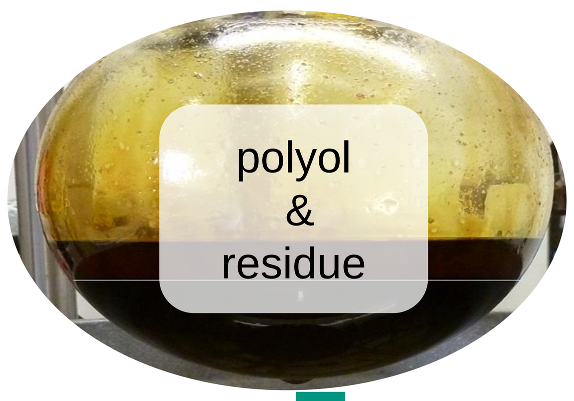
- PUR foam from 100 % recycle polyol (typically around 15 % recycle polyol)



- Foam:
  - MDI-based
  - grinded < 4 mm

- Glycolysis
  - T = 180 °C
  - t = 8 h
  - Solvent: DEG
  - Catalyst: DEOA





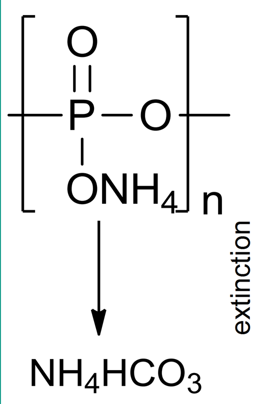
- recycled polyol
  - OH-number: 50 – 90 mg KOH g^{-1} Polyol
  - Mw: 6000 – 8000 g mol^{-1}
  - H_2O-content: < 1 %

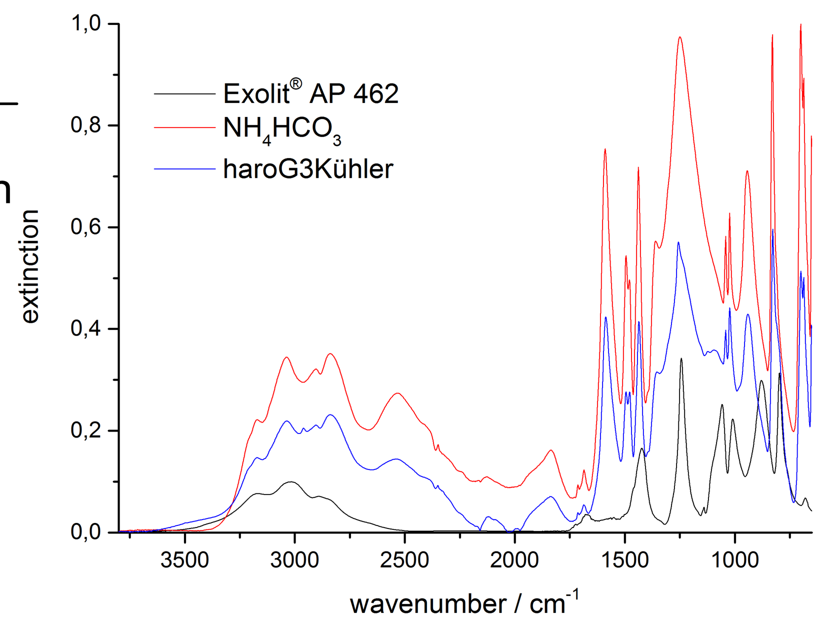
Separation with vacuum destillation

Purity checked by n_D

1.) *Exolit® AP 462 as FR:*

The solid at the reflux condenser was analyzed using ATR technique. The obtained data were in good agreement with the data of ammonium bicarbonate from internal database.



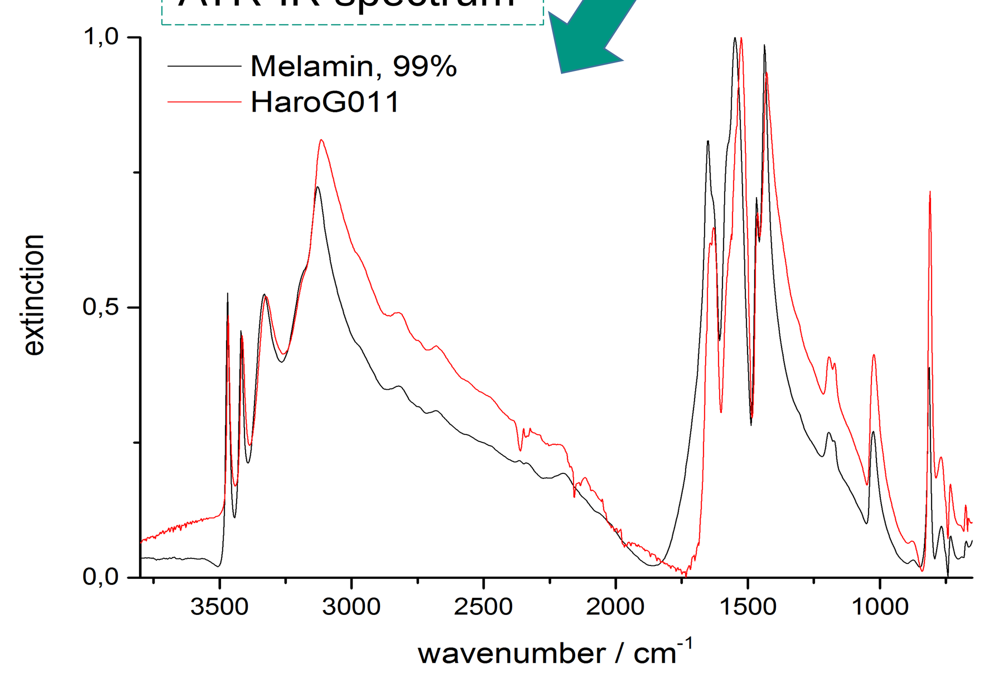


Therefore it is reasonable to assume, that during the glycolysis process APP was converted into ammonium bicarbonate.
In the datasheet of the FR is mentioned a good heat stability until 300 °C.

2.) *Melamine as FR:*

Separation & Recrystallization

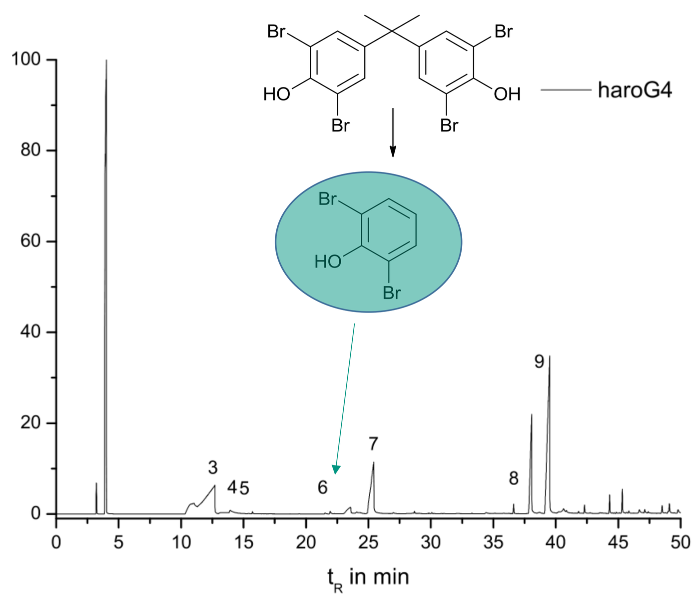
ATR-IR spectrum



The resulting spectrum was in good agreement with the data of pure melamine in the internal database.

3.) *Tetrabromobisphenol A as FR:*

The solution was analyzed by GC-MS reviling presence of 2,6-dibromophenol, a fragment of TBBPA.



No.	t_R in min	compound
1	3,212	ethanol
2	3,897	chloroform
3	12,707	diethylene glycol
4	13,93	diethanolamine
5	15,709	1-(2-hydroxyethyl)piperazine
6	**21,934**	**2,6-dibromophenol**
7	25,428	1,4-bis(2-hydroxyethyl)piperazine
8	36,632	3,3' diaminophenylmethane
9	38,073	4,4' diaminophenylmethane
	39,511	4,4' diaminophenylmethane

Conclusion

It can be summarized that it is possible to recycle melamine from the flexible PU foam. However, during the glycolysis process APP and TBBPA did not outlast the reaction conditions and were converted into ammonium bicarbonate and 2,6-dibromophenol, respectively.

Literature

[1] R. Hanich, *Recycling of flexible polyurethane foam from aircraft seating via glycolysis*, Masterthesis TU Freiberg, **2014**.

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