Release Mechanism of Nicotine in Heat-not-burn Tobacco Products

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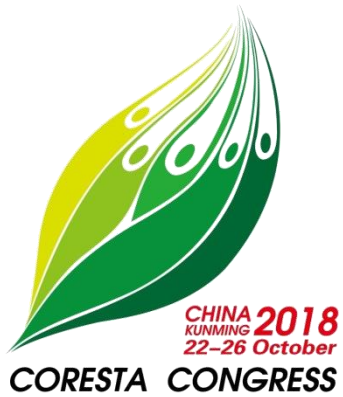
中国烟草 CHINA TOBACCO

SHANGHAI TOBACCO GROUP CO., LTD.

Content

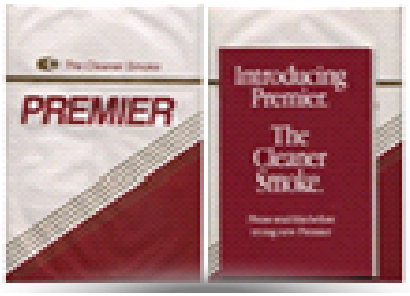


1. Introduction

Introduction

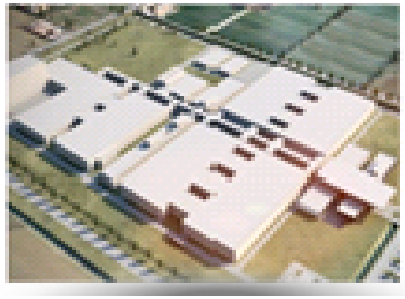
- Heat-not-burn (HNB) tobacco products are devices that heat tobacco to release flavour and nicotine aerosol but not at a high enough temperature to burn it.
- This results in significantly lower levels of toxicants, although independent research is currently limited.

Introduction



1988 R.J. Reynolds Tobacco
Premier
Failed

1999 Philip Morris International
Accord



2014 Philip Morris International
HNB factory

2016 British American Tobacco
Glo

1994 R.J. Reynolds Tobacco
Eclipse
Unsatisfactory

2006 Philip Morris International
Heatbar

2015 Philip Morris International
IQOS
Star Product

R.J. Reynolds Tobacco
REVO

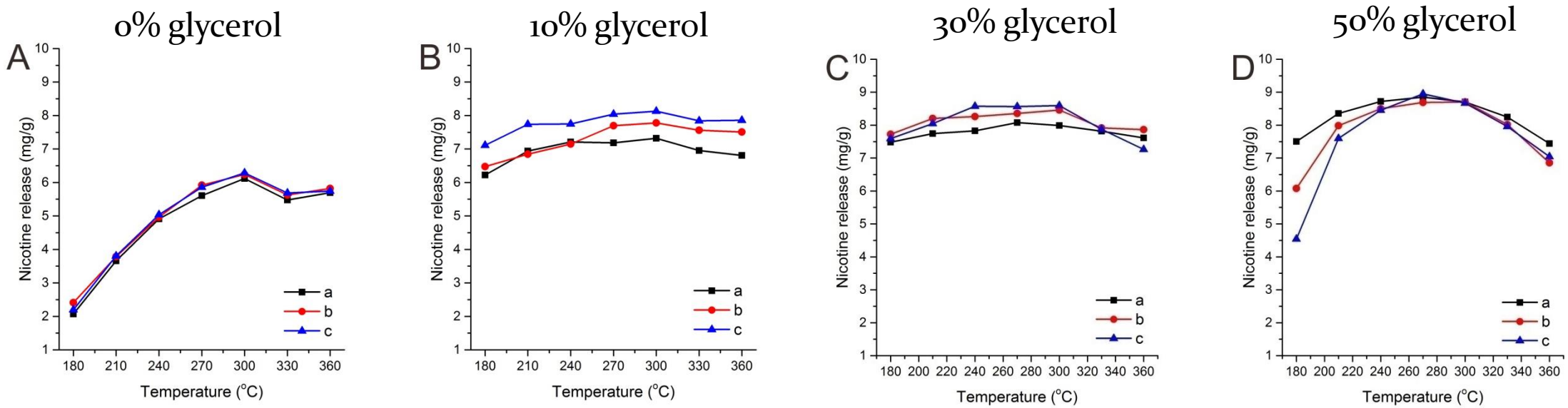
Introduction

Our Ambition is to convince all adult smokers that wish to remain smoking to switch to reduced risk products (RRPs) as soon as possible!

Let us start from the basics to understand the release mechanism of the core value of HNB cigarettes (Nicotine)

2. Study of nicotine release

2.1 Nicotine release of unit dry RTPs

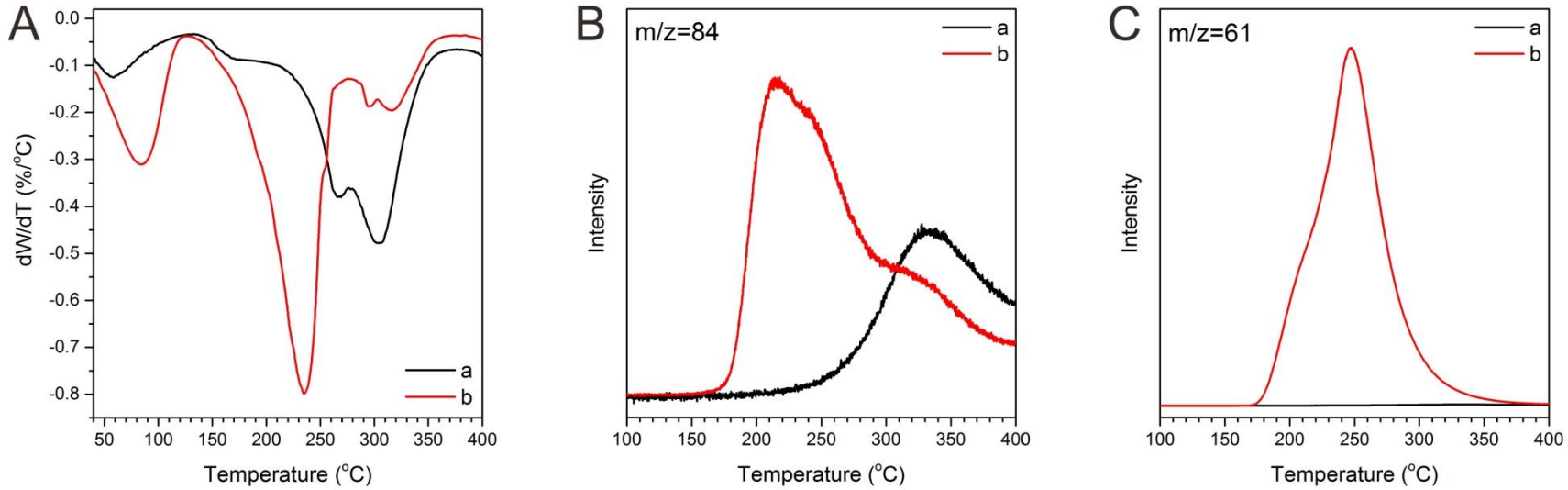


a: 11.6% moisture b: 16% moisture c: 20% moisture

1. Glycerol can enhance the nicotine release in RTPs.
2. Moisture seems to have no effect on nicotine release.

2.2 DTG/GC-MS study

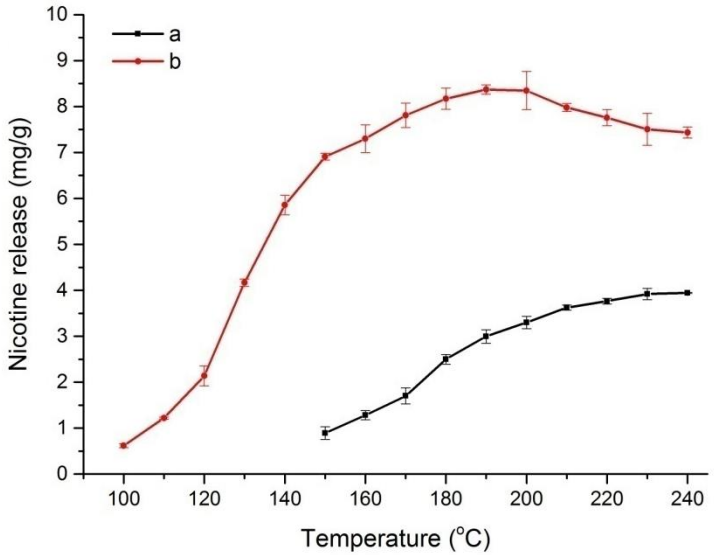
DTG　　MS：nicotine　　MS：glycerol

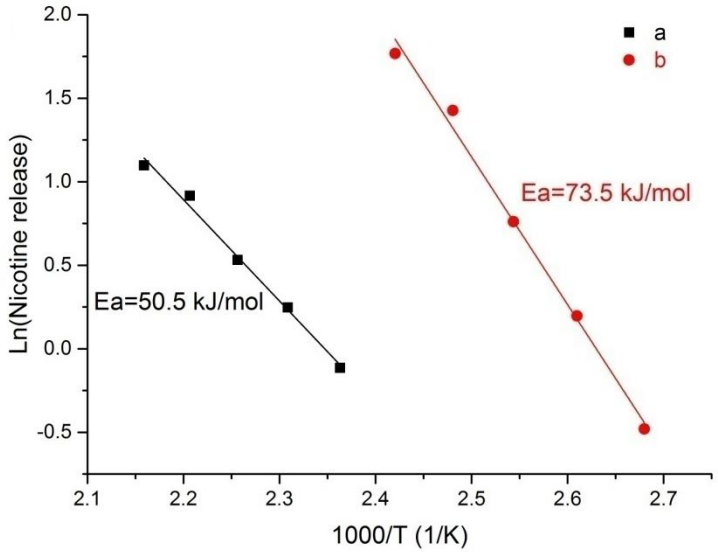


a：0% glycerol，16% moisture　　b：30% glycerol，16% moisture

1. Glycerol improves the nicotine release from RTPs with glycerol;
2. The release of nicotine takes precedence over that of glycerol in RTPs with glycerol.

2.3 Thermodynamic analysis





$$\text{Nicotine release} \propto A \cdot \exp\{-\frac{E_a}{RT}\}$$

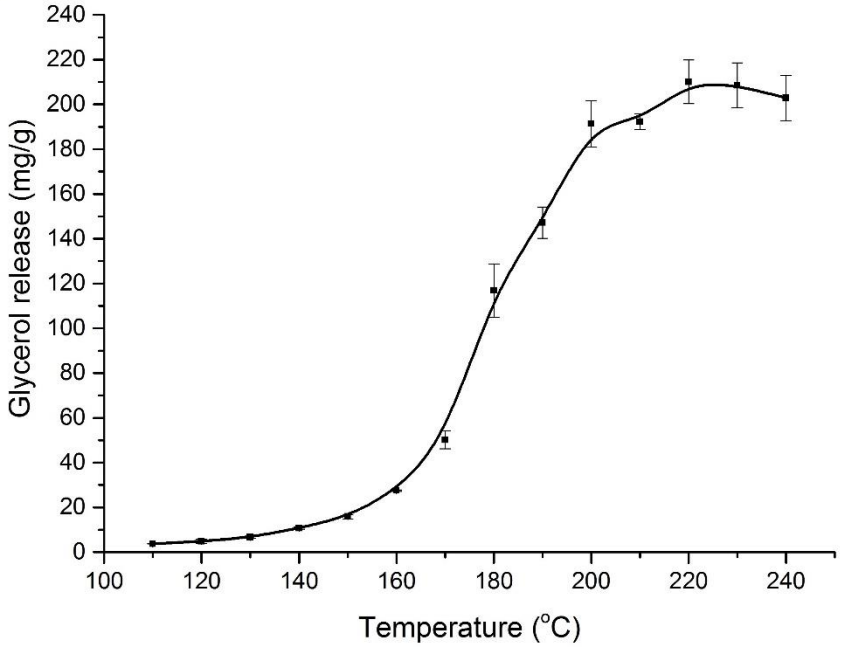
$$\frac{A_b}{A_a} \approx 10^4$$

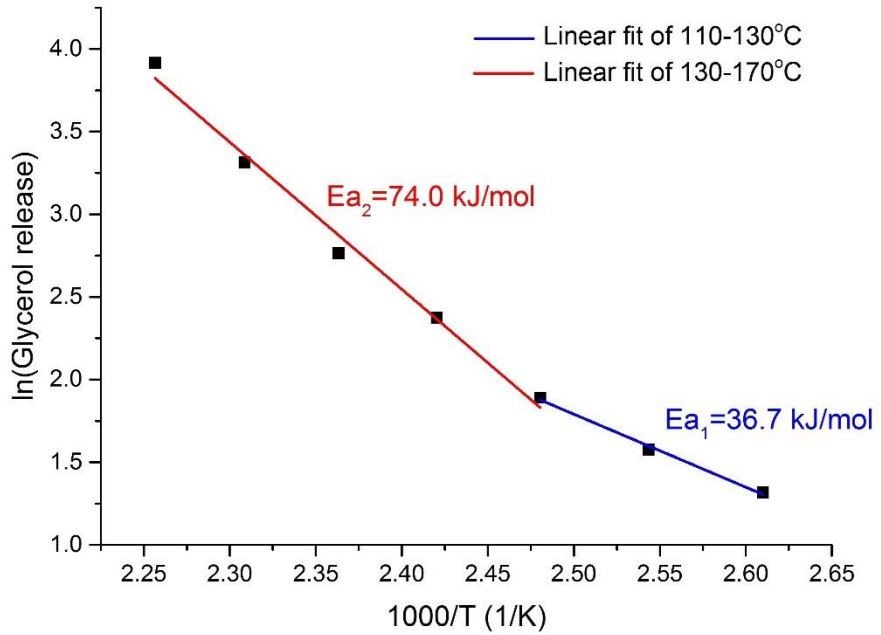
a：0% glycerol， 16% moisture

b：30% glycerol， 16% moisture

1. Nicotine release is controlled by evaporation
2. Glycerol enhances the number of activated nicotine molecules

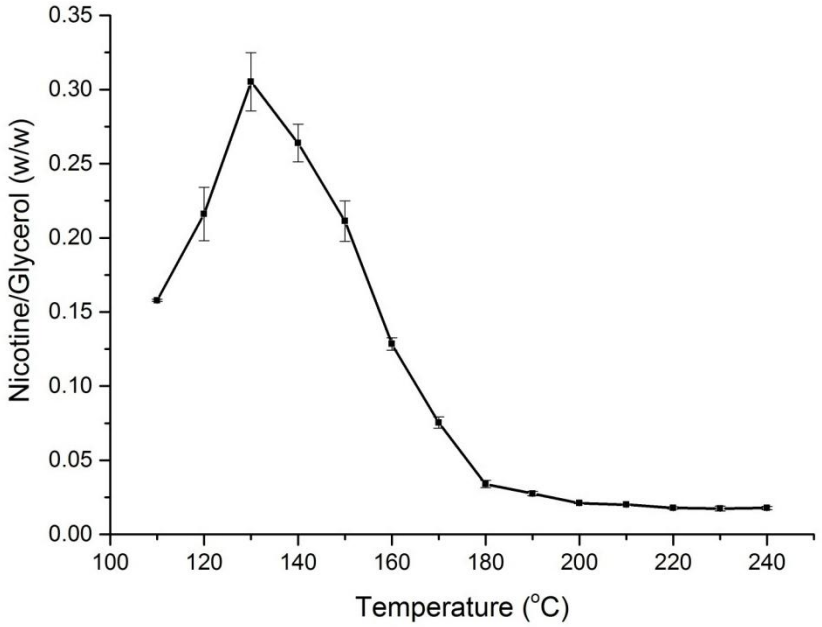
2.3 Thermodynamic analysis

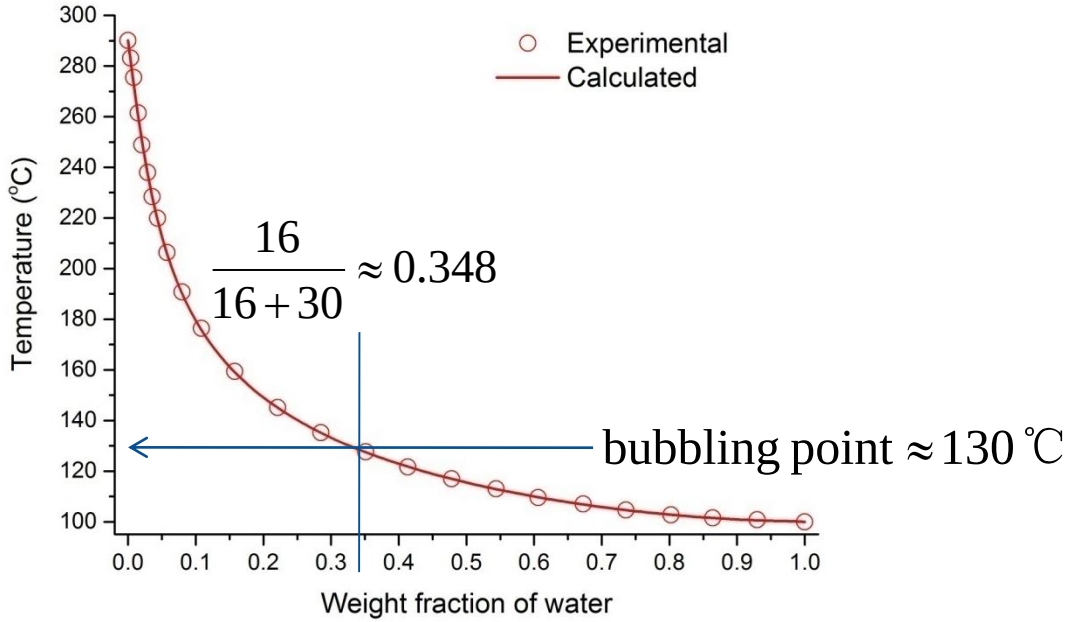




1. 110-130°C： Ea1 is close to the heat of vaporization for water
2. 130-170°C： Ea2 is close to the heat of vaporization for glycerol

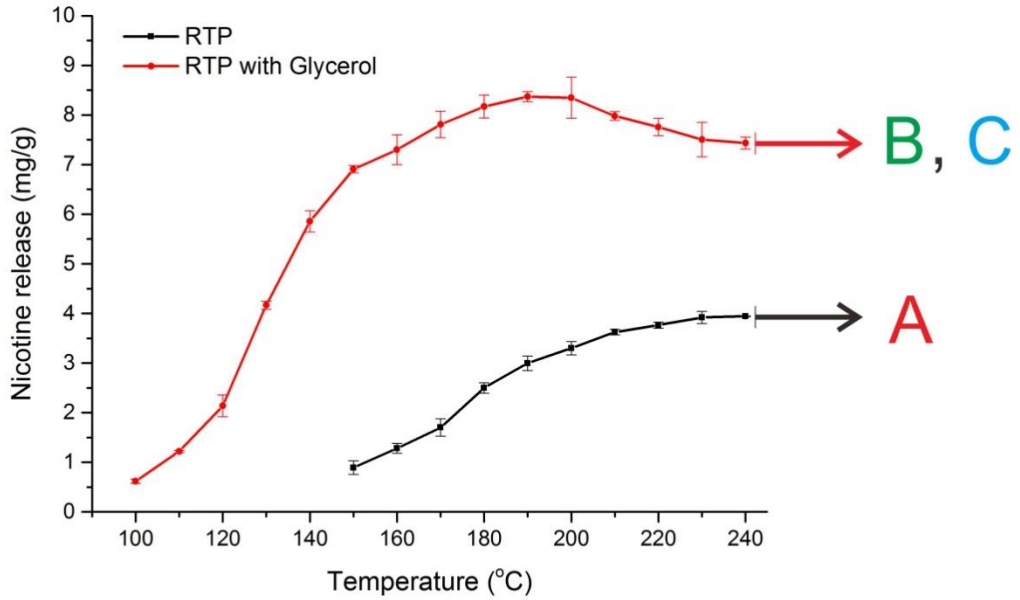
2.4 Effect of bubbling point





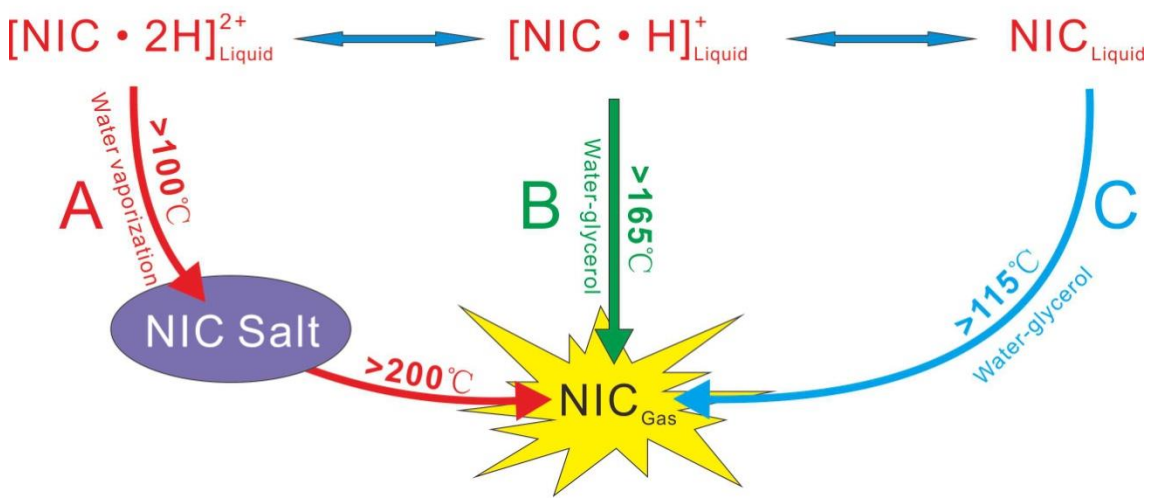
1. The ratio of nicotine to glycerol has the same trend with Ea of glycerol
2. The release pathways of nicotine may be different before and after the bubbling point

2.5 Mechanism of nicotine release



RTP:

$$[NIC \cdot H]^{+}_{Liquid} \leftrightarrow [NIC \cdot 2H]^{2+}_{Liquid} \rightarrow NIC \cdot Salt \rightarrow NIC_{gas}$$



RTP with glycerol:

Above 130℃ : $[NIC \cdot H]^{+}_{Liquid} \rightarrow NIC_{gas}$

110-130℃ : $[NIC \cdot H]^{+}_{Liquid} \leftrightarrow NIC_{Liquid} \rightarrow NIC_{gas}$

3. Conclusion

Conclusion

1. Glycerol, as an atomizing agent, could promote the release of nicotine from new tobacco products.
2. Nicotine releases from its diprotonated form at the temperature more than 200°C for RTPs without glycerol. And RTPs with glycerol, nicotine releases from its nonprotonated form at the temperature range from 110 °C to 130°C, and it releases from its monoprotonated form above 130°C.
3. Glycerol and water in the RTPs will form a water-glycerol system. The bubbling point of the system is higher than pure water. Therefore, nicotine releases from its nonprotonated form and monoprotonated form in RTPs with glycerol.
4. When the temperature raises above 160°C, tobacco products with glycerol can release almost all nicotine in our research.

Thank you for your attention

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