목재 탄화 과정에서 타르 잔사유로부터 부가가치 생화학물질의 분리 및 특성화

광운대학교 환경공학과
대기오염제어 및 에너지 연구실

목 차

Air Pollution Control Lab.

- ❑ 연구배경
- ❑ 실험
- ❑ 예상결과

Pyroligneous acid 연구배경

목초액

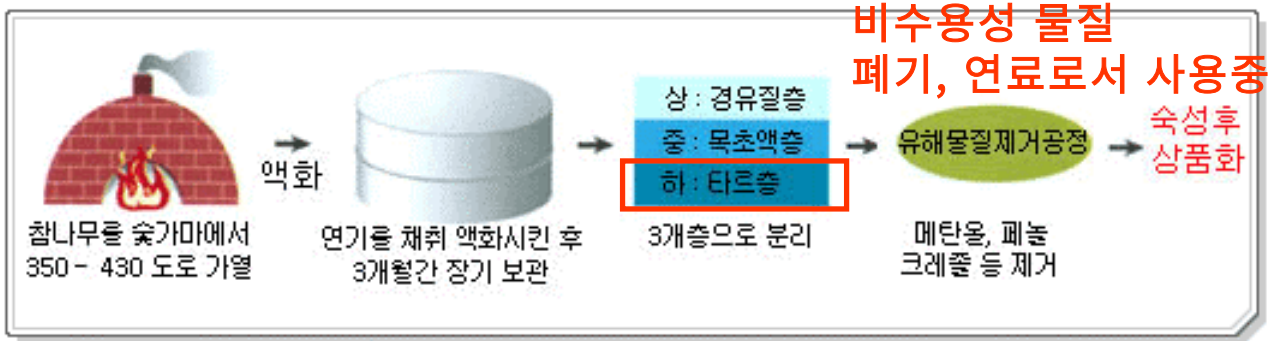
- 활엽수, 침엽수, 죽재류를 탄화(열분해)시키는 과정에서 발생하는 연기를 냉각시켜 얻어지는 응축물이 얻어진다. 이를 일정기간동안 정치하여 분리된 3개의 층 중 위층(경질유)과 아래층(타르)을 분리제거한 가운데층의 수용액을 말함.

생산기준 (산립법시행규칙 제2조, 임업연구원)

- 숯가마 굴뚝의 초입 부분에서 측정하여 재래식의 경우 80~150°C, 기계식의 경우 150°C이하의 것을 냉각시켜 얻은 것.
- 정제목초액의 경우 2~3일간을 정치한 후, 중간층의 갈색액을 3개월이상 정치후, 흡착, 여과, 증류등의 방법의 처리로 탈타르 처리를 한 것.

이용사례

- 생활환경
- 농업
- 축산
- 수산업
- 기타



Major compounds 연구배경

Air Pollution Control Lab.

Table 1. Composition of thermolysis products [ppmw]

RT(MSI	RRF	compound name #1	재래식 타르	기계식 타르	목초액(초롱반	bio-oil(3/15)	죽초액
6.20	2.06	2-furancarboxaldehyde	3828.29	3321.27	56.30	4266.17	12.83
11.80	1.08	phenol	2462.09	3879.89	43.44		156.67
17.40	1.05	o-cresol	1614.35	1886.69	27.61	638.38	
23.00	1.06	m- or p- cresol	3593.20	3766.83	70.53		
28.60	1.41	guaiacol	3471.19	5466.43	56.96	2172.12	
34.20	1.08	2.4-dimethylphenol	1019.32	955.65	17.15		
39.80	1.49	2-methoxy-4-methylphenol	3879.32	11640.52	63.69		
45.40	1.26	4-Ethylguaiacol	5136.81	3480.98	71.22		
51.00	1.44	syringol	16242.51	7698.43	261.30	2517.09	314.92
56.60	1.25	eugenol	1916.50	1999.21			
62.20	1.40	4-propylguaiacol	2862.18		43.42		
67.80	1.92	vanillin		2039.49			
73.40	2.55	cis-isoeugenol		2467.39			
79.00	2.55	trans-isoeugenol	6550.98	7589.90	91.56		
84.60	6.85	levoglucosan				24052.81	
30.42	2.14	syringaldehyde					
31.33	2.00	4-allylsringol	4855.00	6343.50	70.29		

* Internal standard : fluoranthene
RRF : Relatively Response factor, Fast Pyrolysis Handbook(2001)

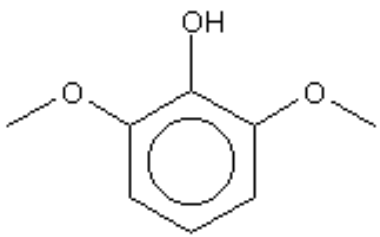
Valued chemicals 연구배경

Table 2. Application of some valuable pyrolytic products

compounds	application	cost
catechol	Antiseptic, photography and dyes. electroplating, antioxidant and speciality inks	0.6$/g
guaiacol	Sweet aroma, burnt aroma, smoky odor used in synthetic flavours and fragrances and pharmaceutical	0.4$/g
4-methylguaiacol	smoky aroma, smoky test, used in food (candy and baked good)	
4-ethylguaiacol	Soya sauce flavour, used in non-alcoholic beverages, ice cream, gelatines and puddings	
syringol	Woody, medicinal and smoky aroma used in food (in meat, soups and seafood), pharmaceutical (platelet aggregation, anti-dermatophyte activity)	1.4$/g
levoglucosan	Pharmaceutical synthesis, pesticides synthesis, specialty carbohydrate polymer, chiral ligands, glucoside surfactants, unique epoxies, urethanes and acrylates	100$/g

Syringol 연구배경

- Smoke flavouring의 주요 성분 중 하나로 적정 수준 이하로 음용 가능.
- 천연 방부제, 훈향의 향료 등 식품첨가제로서 활용이 가능.
- 구조식



2,6-dimethoxyphenol(syringol)

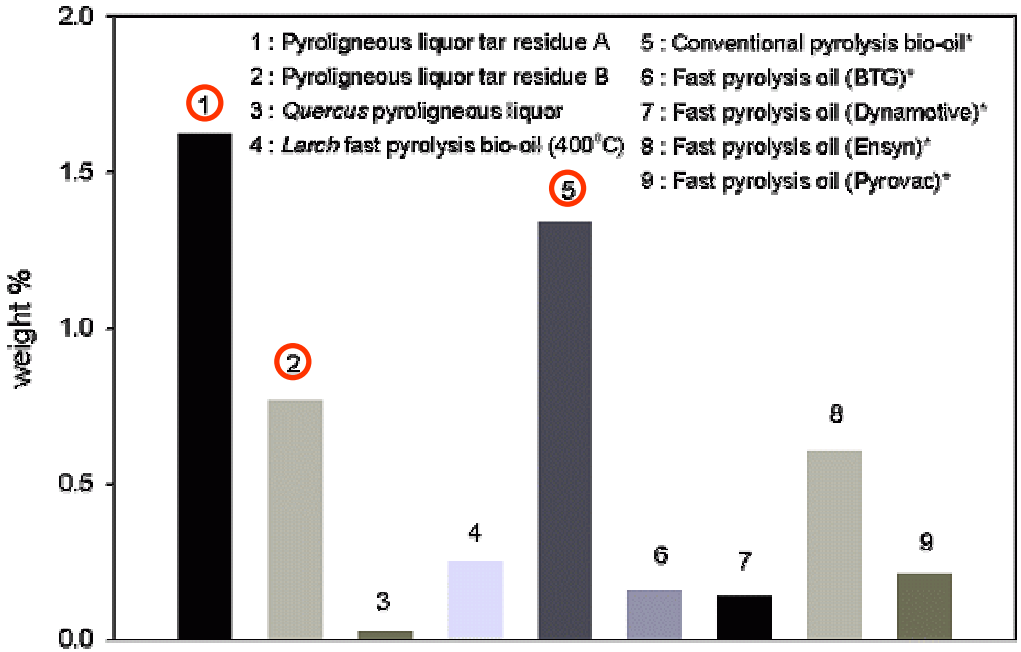


Fig. 3. Syringol content of pyrolytic products.

Experiment 실험

Air Pollution Control Lab.

Quantification

- 각 부가가치 화합물의 함량 파악
- 최적 운전 조건 도출

Steam distillation

- 비 수용성 화합물의 분리

Fractional vacuum distillation

- 끓는점을 이용한 분리 및 농축

Purification

- 용해도차를 이용한 정제

❑ Steam distillation (C.Roy, 2001)

▪ 상호불용성인 두 액체의 혼합물에서 한 성분의 존재는 다른 성분의 증기압을 변화시키지 않고 혼합물을 가열하면 각 성분은 각각 독립으로 증기화하고 두 성분의 혼합물은 증기압 합이 대기압과 같아질 때의 온도에서 증류시키는 것

▪ 이론

- Raoult's law (용액)

$$\frac{p_0 - p}{p_0} = x_2 = \frac{n_2}{n_1 + n_2}$$

- Dalton's law

$$P1 = P^{o}a + P^{o}b + \ldots + P^{o}1$$

▪ 조건

- 물에 불용성이나 난용성
- 화학적 안정성
- 100°C부근에서 증기압 존재
- syringol (bp 261.2 °C)

▪ 실험변수

- Qs/Qo (수증기량/오일량)

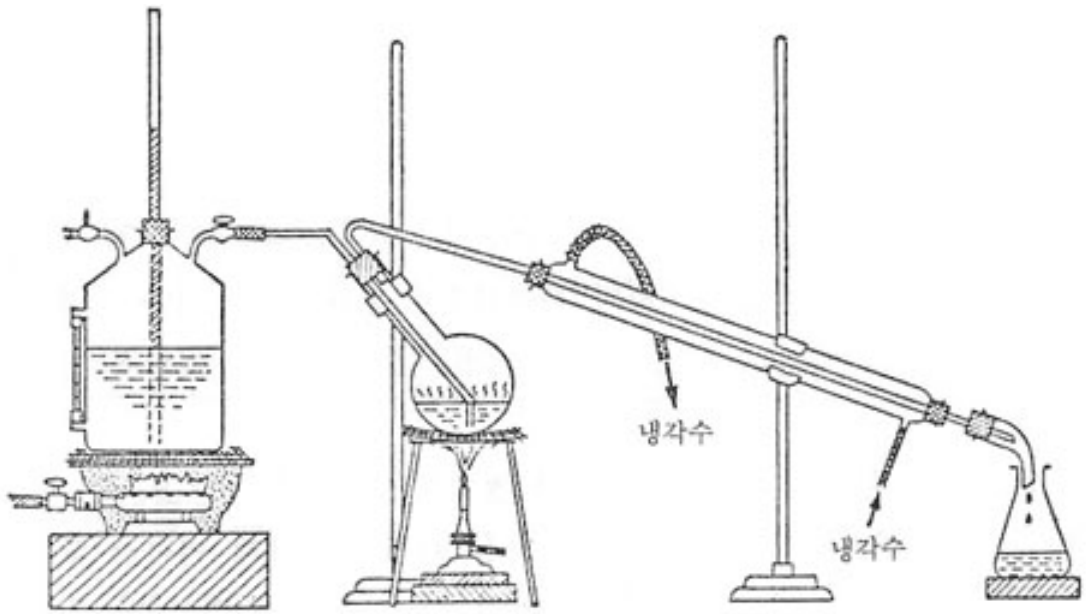


Fig. 4. Scheme of typical steam distillator.

Experiment 실험

- **Fractional vacuum distillation**
  온도를 변수(25~135°C)로 16분획하여 각 분획 분석

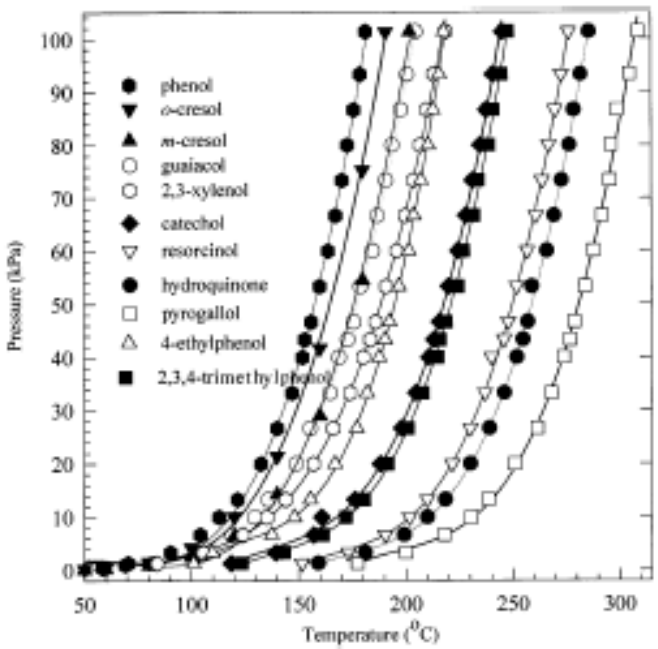


Fig. 5. Vapour pressure of some selected phenols at various temperatures.

- **Purification**
  Solvent extraction

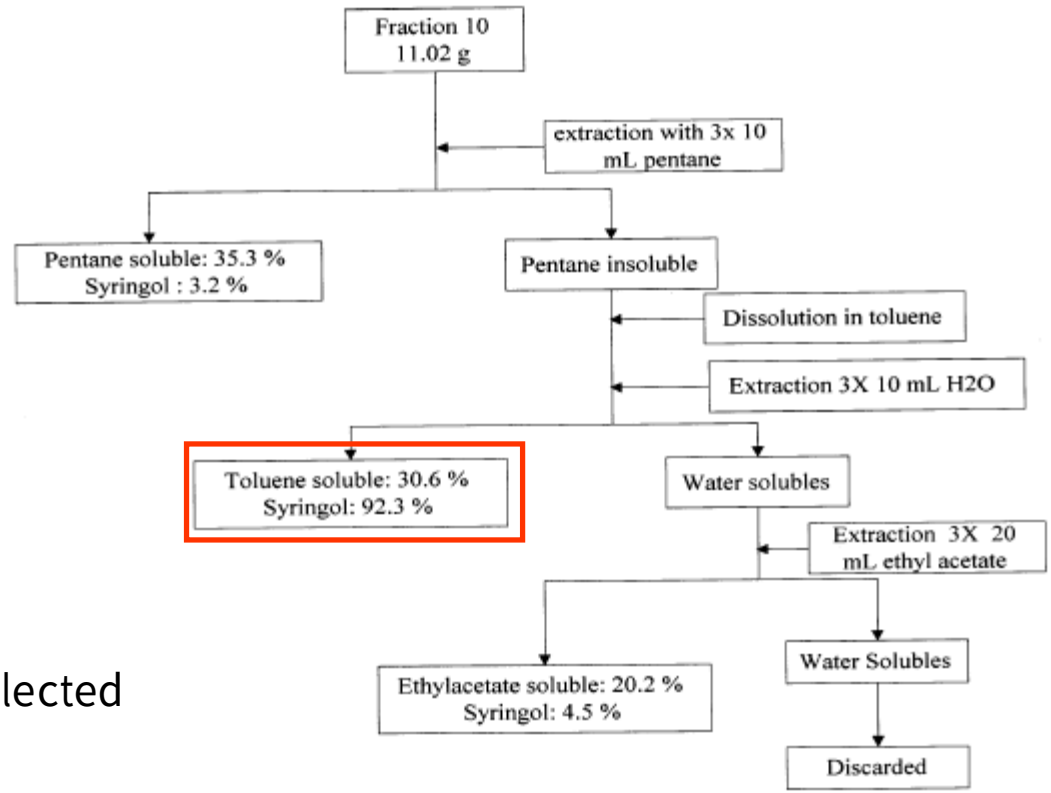


Fig. 6. Syringol purification scheme.

❑ Steam distillation

1) Distillates and total phenols

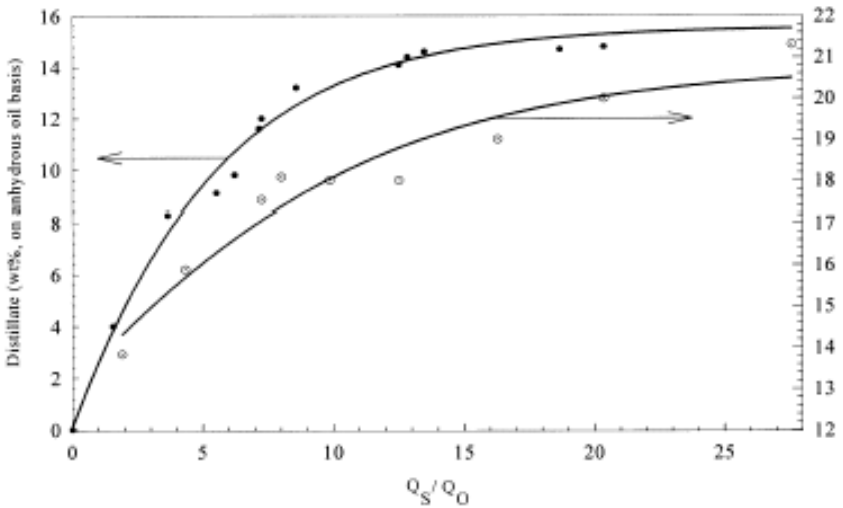


Fig. 7. Evolution of distillates and total phenols as a function of various steam-to-oil ratios.

2) Some selected chemicals

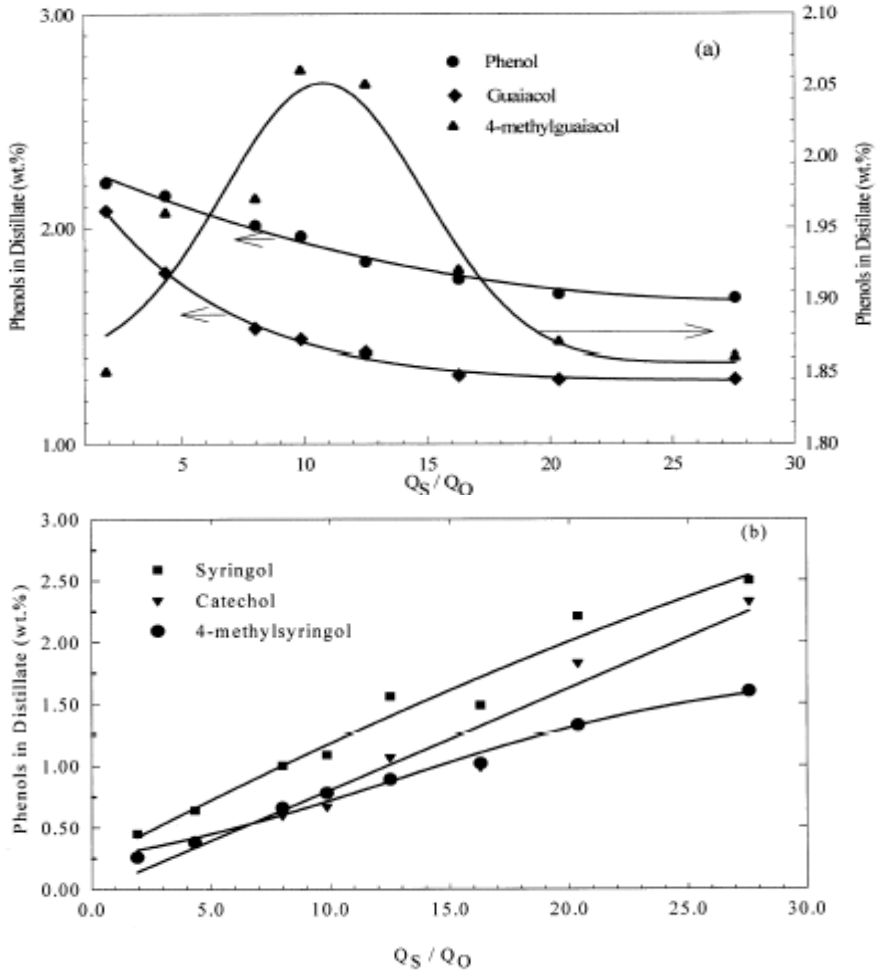


Fig. 8. Evolution of some selected phenols as a function of various steam-to-oil ratios.

❑ Steam distillation

1) Recovery of chemicals

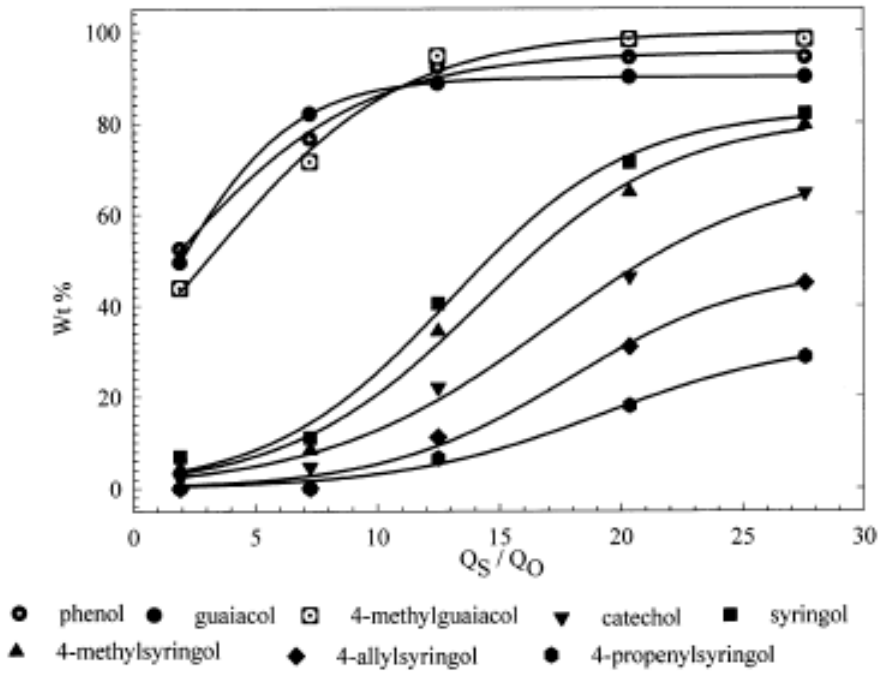


Fig. 9. Evolution of distillates and total phenols as a function of various steam-to-oil ratios.

❑ Fractional vacuum distillation

1) Recovery of distillates

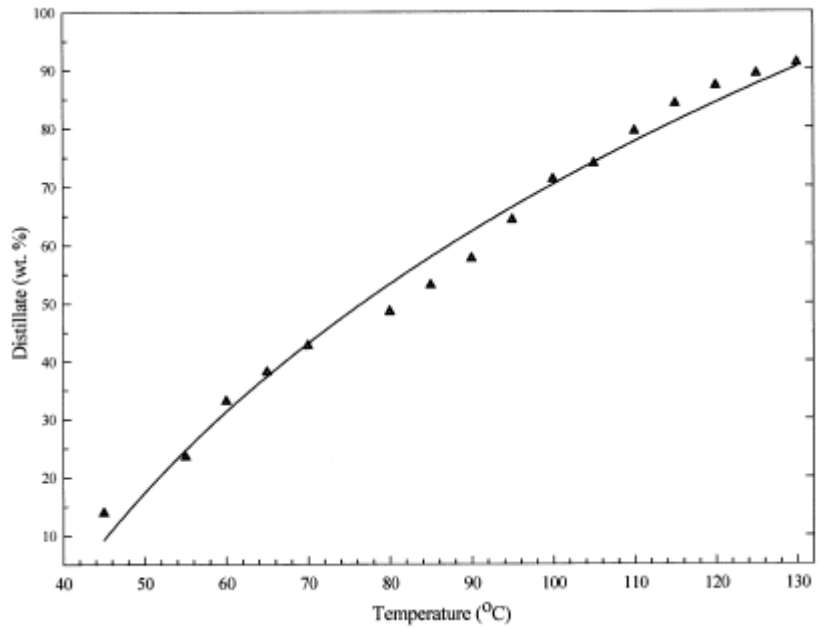


Fig. 10. Evolution of distillates and total phenols as a function of various steam-to-oil ratios.

2) Some selected chemicals

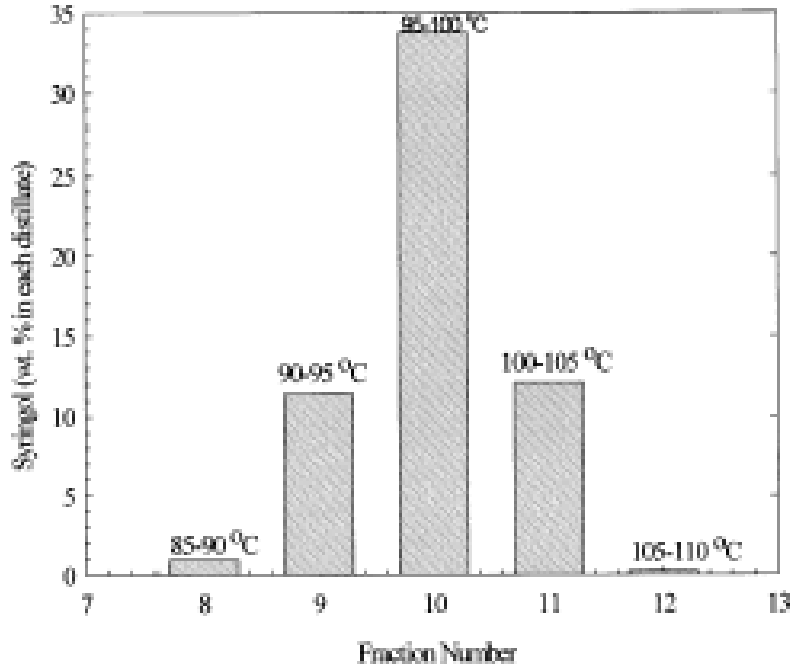


Fig. 11. Evolution of distillates and total phenols as a function of various steam-to-oil ratios.