XII. TABLES AND FIGURES

TABLE XII-1

CHEMICAL AND PHYSICAL PROPERTIES OF PHENOL

Formula	C_6H_5OH
Molecular weight	94.11
pKa (acid dissociation)	9.9
Melting point	40-41 C
Boiling point	181.75 C
Vapor pressure (25 C)	0.35 mm Hg
Specific gravity:	
Solid (25 C)	1.071
Liquid (25 C)	1.049
Relative vapor density	3.24 (air = 1)
Solubility: (X is mole fraction.) Phenol in water: $-\log x = 0.375 \log(66-T) + 1.15$ Water in phenol: $-\log x = -0.62 \log(66-T) + 0.99$ (T is Celsius temperature.)	Also soluble in ether, alcohol, acetic acid, glycerol, liquid sulfur dioxide, and benzene
Color	Colorless to light pink solid
Odor	Sweet; threshold = 1 ppm
Flashpoint:	
Open cup	85 C
Closed cup	79 C
Ignition temperature	715 C
Light sensitivity	Darkens on exposure to light
Saturated vapor concentration (25 C)	461 ppm

From references 1,2,3,135

TABLE XII-2

1972 PHENOL PRODUCTION IN THE US

Process	Production Capacity	
	Millions of Pounds/Yr	Percentage of Total Capacity
Cumene	2100	85.4
Sulfonation	150	6.1
Chlorobenzene	110	4.5
Toluene	50	2.0
Coal Tar	50	2.0
TOTAL	2460	100.0

From Chemical Profiles [5]

TABLE XII-3

1972 USE PATTERN OF PHENOL

Product	Percentage of Total Used
Phenolic resins	50
Caprolactam	20
Bisphenol-A	10
Alkylphenols	6
Adipic acid	4
All other	10
TOTAL	100

From Chemical Profiles [5]

TABLE XII-4

TYPICAL USES OF PHENOL

Applications	References
Bulk Processes:	
phenolic resins	5,7
caprolactam	5,7,28
bisphenol-A	5,7
alkylphenols	5,7
adipic acid	5,7
Production of:	
pharmaceuticals	8-15
dyes	8-20
metal cleaners	21
disinfectants	9,10,13,14,17,22-24
antiseptics	14,16,17,22-25
photographic chemicals	10,16,19,20,26
preservatives	8,10,11,14,18,27
perfumes	9-11,13,14,17,25
paint removers	9,11,22
varnish removers	9,11,22
paints	8,9,11,17,20,22
lacquers	8,9,11,17,20,22
rubber	8,11,14
agricultural chemicals	10,11,13,16
asbestos products	11
illuminating gas	11
lampblack	11
ink	12,27,29
tanning agents	9,14,17,25
Product Synthesis:	
picric acid	9,12,20,30
salicylic acid	9,14
phenates	1,9
phenactin	9
Medical Uses:	
chemotherapy	31-37
intrathecal injections for the relief of flexor spasms	38-48

TABLE XII-5

SELECTED OCCUPATIONAL GROUPS POTENTIALLY EXPOSED TO PHENOL

Occupational Groups	References
Antiseptic workers	16,17,22,23,25
Aromatic compound synthesizers	8,17
Asbestos makers	11,14
Battery makers, dry	321
Chemical makers	9,14,17
Coal tar workers	11,14,22,25,326
Disinfectant makers	9,13,17,18,326
Drug makers	11,22,326
Dyemakers	8,9,13,14,17,326
Dyers	11,326
Etchers	326
Explosives workers	11,13,17,20,25,326
Fertilizer workers	11
Gas employees, illuminating	11,14,326
Gas purifiers	326
Inkmakers	27,84
Insecticide makers	13
Laboratory workers	79,96
Lampblack makers	11,326
Lubricating oil processors	13,326
Metal cleaners	21
Motor oil workers	93
Paintmakers	8,11,326
Paint-remover makers and users	9,11,22,326
Papermakers	8,11,14
Pentachlorophenol makers	326
Perfume makers	9,11,13,17,25,326
Petroleum workers	11
Pharmaceutical makers	8,9,11,13,17
Phenol workers	13,326

TABLE XII-5 (CONTINUED)

SELECTED OCCUPATIONAL GROUPS POTENTIALLY EXPOSED TO PHENOL

Occupational Groups	References
Photographic material workers	14,326
Picric acid makers	9,326
Plastic makers	9,10,11,13,17
Printers	84
Researchers	79,96
Resin makers	8,9,11,13,17,326
Rubber reclaimers	14,326
Rubber workers	8,11,326
Soapmakers	11
Stillmen, carbolic acid	326
Surgical dressing makers	326
Textile printers	326
Tanning substance makers	9,11,14,17,25
Varnish and lacquer makers	8,326
Weed killer users	326
Wood preserver users	8,11,14,326

TABLE XII-6

ADVERSE EFFECTS PRODUCED BY EXPOSURE TO PHENOL

Effects	References
Via Skin Absorption:	
death	20,29,61,69,77,112 119,123,202,204,327,328
local tissue irritation	20,62,65,77,78,111, 202-204,329-332
local tissue necrosis	61,77,78,111,129 202,204,327,330,331,333,334
irregular pulse	29,69,111,112,129,115,204,328
darkened urine	62,65,66,77,111,129,204,328
stertorous breathing	77,111,112,129,202,204
collapse	29,112,129,202,204,327,331
vomiting	66,69,77,111,112, 129,192,202
cold extremities	65,66,129,202
coma	77,112
pallor	61,62,65
cyanosis	65,77,111
convulsions	112,129,202
reduced body temperature	65,111,112
elevated body temperature	77,129,112
dilated pupils	69,112,129,204
constricted pupils	111,112,129,202,204
absence of corneal reflexes	111,112,202
difficulty in swallowing	69,111
profuse perspiration	66,111,112,129
rales	61,77,111,202,328
odor of phenol on breath	65,77
headache	29,62,112,328
vertigo	66,77,129,331
euphoria	62,111,112
dyspnea	112,129,331
ochronosis (acquired)	58-61
general fatigue	29,66,111,129
local edema	76,115,203
pulmonary edema	331
abdominal edema	77
anuria	66,202
local anesthesia	66,77,111,203,329,330,332

TABLE XII-6 (CONTINUED)

ADVERSE EFFECTS PRODUCED BY EXPOSURE TO PHENOL

Effects	References
Via Skin Absorption (continued)	
albuminura	66
hematuria	202
damage to kidney tissue	62,66,331
abdominal pain	202
anemia	62
depression	29
liver damage	129,202,331
damage to blood-forming organs	62,331
increased irritability	329
loss of appetite	328
diarrhea	328
Via Inhalation:	
death	110,328
local tissue irritation	56,63,110
local tissue necrosis	110
irregular pulse	56,63,65,110
darkened urine	56,65,110
stertorous breathing	63,65,110
collapse	110,328
cold extremities	63,328
coma	63,65,328
cyanosis	71
constricted pupils	328
convulsions	63
reduced body temperature	110
difficulty in swallowing	56
profuse perspiration	56,65
odor of phenol on breath	63
euphoria	110
unusual thirst	328
pulmonary edema	110
abdominal pain	63
giddiness	63

TABLE XII-6 (CONTINUED)

ADVERSE EFFECTS PRODUCED BY EXPOSURE TO PHENOL

Effects	References
Via Ingestion:	
death	64,70,71,107-109, 205,327,335-337
local tissue irritation	68-70,107,109,336,337
local tissue necrosis	68-71,107-109, 205,336-338
irregular pulse	67,68,71,107,109,205,336,338
darkened urine	71,107,109,336
stertorous breathing	109,205,327,336,338
collapse	56,69,71,107,205
vomiting	68,107,108,205
cold extremities	69,71,107,205,336
coma	67-71,107
convulsions	68,71,205
dilated pupils	107,327
constricted pupils	69-71,205
absence of corneal reflexes	69-71,109
odor of phenol on breath	68-71,107,327
reduced body temperature	71,107,337
elevated body temperature	108
difficulty in swallowing	68,71,107
rales	67,68
headache	68
unusual thirst	69,109
increased irritability	68
euphoria	108
dyspnea	71
pulmonary edema	68,107,108
abdominal edema	107
anuria	68
albuminuria	68,107
giddiness	56
delirium	71
hematuria	68,107
abdominal pain	70,107,205
liver damage	107
low blood pressure	68
nausea	68,107
burning sensation in the throat	56,107,69
abortion	69,109

TABLE XII-6 (CONTINUED)

ADVERSE EFFECTS PRODUCED BY EXPOSURE TO PHENOL

Effects	References
Via Contact with Open Wounds:	
death	55,59,60,328
local tissue irritation	55,106,339
local tissue necrosis	55,60,106,339,340
irregular pulse	106
darkened urine	58,59,60,106,112,341
collapse	341
vomiting	106,328,341
coma	341
pallor	58,59,106,112
cyanosis	341
dilated pupils	341
difficulty in swallowing	106
vertigo	58
ochronosis (acquired)	58,59,60
general fatigue	58,341
unusual thirst	112
local edema	58,340
anuria	112
local anesthesia	55
tinnitus	58
loss of appetite	106

TABLE XII-6 (CONTINUED)

ADVERSE EFFECTS PRODUCED BY EXPOSURE TO PHENOL

Effects	References
Via Contact with Mucous Membranes:	
Uterus-	
death	342
local tissue irritation	342,343
collapse	342
local tissue necrosis	342,343
irregular pulse	342
darkened urine	343
absence of corneal reflexes	342
hematuria	343
damage to blood-forming organs	343
anemia	343
diarrhea	342
Peritoneum-	
local tissue irritation	344
local tissue necrosis	344
diarrhea	328
Via Intramuscular Injection:	
death	345
local tissue necrosis	345,346
constricted pupils	345,346
irregular pulse	345,346
collapse	345,346
vomiting	345,346
reduced body temperature	345
stertorous breathing	346

TABLE XII-7

HUMAN RESPONSES TO PHENOL AT VARIOUS DURATIONS AND AIRBORNE CONCENTRATIONS

Concentration		Duration of Exposure	N	Response	References
ppm	mg/cu m				
48 + 8 ppm HCHO	185 + 9.8 HCHO	5-10 min/hr, 8 hrs/day	?	Marked irritation of the nose, throat, and eyes. HCHO may be primary cause.	95
1.5-5.2	6-20	8 hrs with 2 30-min breaks	8	No ill effects. 60-88% of phenol absorbed by lungs. Rise in urinary excretion of phenol during exposure with a return to preexposure levels within 24 hrs	97
0-3.3	0-12.5	8 hrs/day	?	No ill effect. Rise in urinary phenol	88
2.3-3.2 (in coke quench effluent)	8.8-12.2 (in coke quench effluent)	8 hrs/day	29	"Poisoning"	88
0.047	0.18	Minutes	4	Odor threshold average	135
0.006-0.048	0.022-0.184	"	14	Odor threshold range	17
0.006-0.024	0.022-0.094	"	19	"	136
0.006	0.024	15 sec	4	Conditioned electrocortical reflex in all	17
0.004	0.0155	5 min	3	Increased sensitivity to light in dark adapted people	17

mg/liter of effluent

TABLE XII-8

HUMAN RESPONSES TO SKIN CONTACT WITH PHENOL

Concentration % phenol	Medium	Contact Duration	Circumstances	N	Most Severe Response	References
100	Crystals	30 min	In glove	1	Gangrene	80
100	Liquefied	5-10 min	Spill on cheeks & scalp	1	Death	204
100	"	5-7 min	Explosion	1	"	96
80-100	Water	20 min	Spill on hip, thigh, scrotum	1	"	202
80-100	"	2-4 days	Closed dressings on open wounds	11	1 death, 8 gas gangrene, 11 tissue necrosis	55
97	Cresols & water	Less than 5 min	Broken flask in lab	1	Burns on hands, later fatigue, blurred vision, weakness	96
"Strong"	Water	10 min	Spill on scalp, face, neck, shoulders, and back	1	Death	129
?	Ergot salve	20 yrs	Applied daily on eczematous back	1	Invasive epithelioma	89
90	Water	20 sec 12 min 31 min 1 hr 2 hrs 44 hrs 5-7 days	Self-exposure-- 1 drop on forearm	1	Some local irritation Edema, anesthesia Burning sensation Increasing pain & edema Increased sensitivity to touch Desquamation Crusting & sloughing	203
78	Water	2-5 min	4-5 liter spill on upper body	1	Coma	86
43.5	Waste water (cresols 14%, low boiling organics 11.5%, high boiling organics 11%, water 20%)	1 min	Spill on lower body, irrigation with warm water for 30 min, followed by swabbing with ethanol for 10 min, followed by repetition of procedure	1	Shock	82
20	Lard	1 5 hrs	Covered with impervious dressing	1	Coma	
11	Olive oil	7 wks	Covered dressing	1	Vomiting, dysphagia, dark urine	59
5	Oil	30 yrs	Closed dressing on ulcerated skin	1	Ochronosis (acquired)	59
5	"	12 yrs	"	1	Death	60
5	"	10 yrs	"	1	Ochronosis (acquired)	61
5	"	3 yrs	"	1	"	58
5	Salve	7 days	Closed dressing on cut	1	Gangrene	339
5	Iodoform & zinc oxide	5 days	Closed dressing over rash on toe	1	"	84

TABLE XII-8 (CONTINUED)

HUMAN RESPONSES TO SKIN CONTACT WITH PHENOL

Concentration phenol	Medium	Contact Duration	Circumstances	N	Most Severe Response	References
5	Water	14.5 hr	Phenol soaked compress on thigh abscess	1	Coma	112
5	"	70 min	Phenol soaked compress on broken skin	1	"	112
<5	"	16-20 hrs	Closed soaked dressing on finger	1	Gangrene	340
4.75	Camphor	1- 7 days	Painted on hand, arms, feet, & lower abdomen	3	Local tissue necrosis	90
4	Water + boric acid	16-20 hrs	Applied twice on head, arms, & thighs	1	Cyanotic, rapid pulse, kidney damage	348
4	Water	7.5 hrs	Rubbed on chest, abdomen, & back	1	Coma	66
2.5	"	2 hrs	Legs wrapped in soaked towels	1	"	341
2.5	"	3 min	Stale bread poultice over entire body	1	"	111
2	"	2.5 days	Moist dressing over burns on 30% of body surface	1	Death	77
2	"	11 hrs	Closed bandage on infant umbilicus		"	87
1%	Calamine & zinc lotion	Daily for 17 days	Rubbed on scalp, arms, chest, back, & legs	1	Coma	128
6.4-6.6 ppm	Vapor exposure	5.5 hrs	No inhalation dose, naked	8	Increased urinary phenol, no effects	97
5.8-6.8 ppm	"	"	No inhalation dose, clothed in underwear and denim overalls	8	"	97
2.4-2.5 ppm	"	"	"	8	"	97
1.2-1.4 ppm	"	"	"	8	"	97

TABLE XII-9

HUMAN RESPONSE ON INGESTION OF PHENOL

Concentration % phenol	Dose ml solution	Dose g phenol	N	Time Prior to Treatment	Response	References
100	120	128	1	45 min	Death	69
100	60	64	1	Shortly	"	71
100	60	64	1	1.5 hrs	"	70
88	60	56	1	45 min	Collapse	75
90	40	39	1	1 hr	Death	109
100	30	32	1	Min	"	71
100	30	32	1	50 min	Coma	68
100	30	32	1	15 min	"	75
82	30	26	1	3 min	Death	327
100	15	16	1	1.5 hr	"	75
100	10-20	11-21	1	25 min	"	76
15	30	4.8	1	10 min	"	205
0.9	45 (3-4 times/ day)	0.43 (3-4 times/ day)	Several	---	Burning sensation followed by giddiness, cold, profuse perspiration, weak pulse, green tint to urine	56
2	60	1.3	1	24 hr	No effect	206
0.2	45 (3-4 times/ day)	0.096 (3-4 times/ day)	Several	---	"	56

TABLE XII-10

PHENOL CONCENTRATIONS IN HUMAN BLOOD

Exposure	Route of Entry	Time Prior to Sampling	Phenol Concentration (mg/100 ml) Free	Conjugated	Analytical Method	References
None	____	____	None or traces	0.0-0.8	Millon's reagent	139
"	____	____	None	0.07-0.9	"	140
"	____	____	0.02	____	p-Nitroaniline	141
"	____	____	0.0-0.04	0.155	Millon's reagent	142
"	____	____	0.05-0.8	0.1-0.15	p-Nitroaniline	143 144
"	____	____	____	1.8-5.96 (total phenol)	Bromo-iodometric titration	149
"	____	____	1.36-1.67	0.06-0.3	p-Nitroaniline	145
"	____	____	1-2	0-0.2	"	146
"	____	____	1.8-2.4	0.17-0.8	Phosphotungstic-phosphomolybdic acid color reagent	147
"	____	____	2-4	2.6-6 (total phenol)	Xanthoprotic reaction	148
None	____	____	None	1.87-7.96 (total phenol)	Phosphotungstic-phosphomolybdic acid color reagent	150
"	____	____	0.15	0.35	p-Nitroaniline	137
1-4 g Phenol (2%) in calamine lotion	Dermal application	2-hour intervals, 1-3 days	0.4	1.1-1.92	"	137
1-4 g Phenol (4.75%) as phenol-camphor in liquid petrolatum	Dermal application	2-hour intervals, 1-3 days	0.4	0.9-1.73	"	137

TABLE XII-11

PHENOL CONCENTRATIONS IN HUMAN URINE

Exposure	Route of Entry	Time Prior to Sampling	Phenol Concentration (mg/l) Free	Conjugated	Analytical Method	References
None	———	———	0.04-0.56	1.06-5.18	GLC	152
"	———	———	———	0.5 -30.8 (total phenol)	"	152
"	———	———	———	1.0 -27.0 (total phenol)	Gibbs reagent	152
"	———	———	———	9 (total phenol)	?	153
"	———	———	———	2-18 (total phenol)	GLC	154
"	———	———	———	7.8 (total phenol)	Gibbs reagent	155
"	———	———	———	3.4 -22 (total phenol) (majority-free phenol)	Phosphotungstic-phosphomolybdic acid color reagent	151
"	———	———	———	3-28 (total phenol)	Gravimetric as tribromophenol	156
"	———	———	———	30 (total phenol)	p-Nitroaniline	157
"	———	———	———	60 (total phenol)	Mooser's procedure	158
"	———	———	———	6.0-60.6 6 -63 (total phenol)	p-Nitroaniline	138
"	———	———	———	8.3-81.5 (total phenol)	Gibb's reagent	128
"	———	———	———	4-14 (total phenol)	?	97
18.3 mg/cu m	Inhalation only, 8 hrs	At termination of exposure		100 (total phenol)	?	97
24.4 mg/cu m	Skin only, 6 hrs	"	----	100 (total phenol)	?	98
8.8 mg/cu m	Inhalation, possibly skin	Preshift, 6th day of work	25 mg/g creatinine	90 mg/g creatinine	Gibb's reagent	98
"	"	Postshift, 6th day	30 mg/g creatinine	290 mg/g creatinine	"	98
"	"	Preshift, 2 days no exposure	25 mg/g creatinine	35 mg/g creatinine	"	98
"	"	Postshift, 2 days no exposure	"	180 mg/g creatinine	"	

TABLE XII-12

ANIMAL RESPONSES FOLLOWING ACUTE PHENOL EXPOSURES

Species	Route of Entry	mg/kg	Medium	Time	N	Response	References
Cat	Oral	50-100	Petrolatum	1-2 hrs	?	Death	162
"	iv	50	Water	?	?	All died	164
"	"	1.2-20 (0.5% soln)	0.9% NaCl	10 hrs	4 groups of 2 each; 3 groups of 1 each	1 death at highest dose, chronic convulsion, increased salivation, ataxia, dilated pupils, increased respiratory rate at intermediate doses. No effects at lower doses	164
"	sc	80 (10% soln)	Olive oil	7 days	?	Dose killing approximately 50% of animals	163
"	"	1.2-15 (0.5% soln) 1-5 daily injections-	0.9% NaCl	16 hrs-6 day	5 groups, of 1 to 3 each group	1 death with repeated daily injections at intermediate dose; inappetence and diarrhea at high doses inappentence at low doses	164
Dog	Oral	275	Petrolatum	1-2 hrs	?	Death	162
"	"	37.2-64.2 (24 hr fast)	Water	?	3	Survived	165
"	"	37.2-64.2 (24 hr fast)	Water	?	3	Survived	165
Dog	Oral	320 -430 (20 mg/kg morphine previously)	Liquified	6 days	1 group of 10 1 group of 4	Death of 10 at high dose, in 1 to 6 days; 2 deaths at low dose in 2 - 3 days	166
"	iv	100	Water	?	?	Neuromuscular irritability, convulsions, coma, all survived. Frequent intravascular hemolyst and darkened urine containing protein, hemoglobin, and bilirubin, kidney damage	167
Goat	"	100	"	?	?	"	167
Guinea pig	ip	100-1000 (10% soln)	Olive oil	24 hrs	5	Tremor, convulsions, paralysis at doses of 300 or below, death at each of 3 higher doses	168
"	"	150-400	Water	24 hrs	6	1 death at doses of 400 and 300; tremor, convulsions, and paralysis for 2 animals at a dose of 300, and for 1 animal each at doses of 200 and 150	168
Pig	"	100	"	?	?	"	167

TABLE XII-12 (CONTINUED)

ANIMAL RESPONSES FOLLOWING ACUTE PHENOL EXPOSURES

Species	Route of Entry	mg/kg	Medium	Time	N	Response	References
Rabbit	Eye	1 drop (87% phenol)	Glycerin	Minutes to 3 days	?	Complete destruction of the eye in minutes. Corneal opacities in 40% of animals if water irrigation delayed 10 seconds or more; and no effect if water irrigation performed immediately	170
"	Skin	1600-6400 (20% emulsion)	Water	24 hrs	3	All died	170
"	"	200-800 (20% emulsion)	"	"	3	Survived	170
"	"	50-1600 (5% soln)	"	"	6	"	170
"	"	20-80 (1% soln)	"	"	4	"	170
"	"	5000 (4.75% soln)	Camphor-liquid petrolatum	7 days	3	2 died, 1 showed mild hyperemia	169
"	"	2000 (4.75% soln)	Pure liquid to 10% water emulsion	"	82 (7 groups	30% died on exposure to pure liquid with % deaths increasing inversely to % of phenol in water resulting in 100% deaths with application of a 10% emulsion	163
Rabbit	Skin	64-380 (1.18%-7.12% soln)	Water	" "	24 (6 groups)	1 death and tissue necrosis at highest dose, severe tremor at intermediate doses, and mild hyperemia and mild tremor at lower doses	169
"	"	250 (4.75% soln)	Camphor-liquid petrolatum	"	4	Mild hypermia, tremor, hyperkeratosis in 1	169
"	Oral	280-620	Water	"	34	All 20 at high dose died, 5 out 10 died at a dose of 420, and remaining 4 survived the low dose	163
"	iv	180 (5% soln)	"	"	1	Death in about 50%	163
"	sc	620 (5% soln)	"	"	1	"	163
"	ip	620 (5% soln)	"	"	1	"	163
Rat	Skin	670	"	24 hrs	40	Muscle tremors, convulsions	172
"	"	107	Liquified	"	10		172
"	"	(4.75% soln) 1 hr/day, 30 days	Camphor-liquid petrolatum	42 days	10	Increased severity of mild hyperemia compared to controls	169
"		1 hr/day, 3 days					

TABLE XII-12 (CONTINUED)

ANIMAL RESPONSES FOLLOWING ACUTE PHENOL EXPOSURES

Species	Route of Entry	mg/kg	Medium	Time	N	Response	References
Rat	Skin	(2.75% soln) 1 hr/day, 3 days	Petrolatum	7 days	50	Death in about 50%	169
"	"	(6.6% soln) 1 hr/day, 3 days	Water	"	40	"	169
"	"	(4.15% soln) 1 hr/day, 3 days	"	"	5		169
"	"	(1.75% soln)	Petrolatum	"	5	"	169
"	Oral	530-550 (2% soln to 10% soln)	Water	"	45-80 (4 groups)	Death in about 50%	163
"	"	1500 (10% soln)	Olive oil	"	10	"	163
"	"	340 (20% emulsion)	Water	"	45	"	163

TABLE XII-13

DOSE-RESPONSE RELATIONSHIPS FOLLOWING INHALATION OF PHENOL BY ANIMALS

Species	Concentration ppm	Concentration mg/cu m	Time	N	Response	References
Guinea pig	26-52	100-200	7 hrs/day, 5 days/wk	12	29 exposures, 5 deaths Post mortem revealed extensive necrosis of the myocardium, acute lobular pneumonia, and damage to vascular, hepatic, and renal tissue.	174
Monkey	5	19	8 hrs/day, 5 days/wk, 90 days	10	General health, hematology, urinalysis, blood chemistry, kidney function, stress tests, and post mortem pathology and histology same as controls. Weight gain over controls ($p < 0.05$)	180
Mouse	5	19	"	100	General health, hematology, urinalysis, blood chemistry, kidney function, body weight and post-mortem pathology and histology same as controls. Stress tests revealed increased endurance over controls ($p < 0.05$)	180
Rabbit	26-52	100-200	7 hrs/day, 5 days/wk, 63 exposures/ 88 days	6	No signs of illness or discomfort. Post mortem revealed lobular pneumonia, chronic purulent bronchitis, degenerative changes in pulmonary blood vessels, myocardial degeneration, and indications of liver & kidney damage	174
Rat	26-52	100-200	7 hrs/day, 5 days/wk, 53 exposures/ 74 days	15	No signs of illness. Post-mortem showed no pathologic or histologic changes	174
Rat	5	19	8 hrs/day,	50	General health, hematology, urinalysis, cytology same as controls. Weight gain over controls ($p < 0.05$)	180
Mouse	5	19	"	100	General health, hematology, urinalysis, blood chemistry, kidney function, body weight and post-mortem pathology and histology same as controls. Stress tests revealed increased endurance over controls ($p < 0.05$)	180
Rabbit	26-52	100-200	7 hrs/day, 5 days/wk, 63 exposures/ 5 days/wk, 90 days	6	No signs of illness or discomfort. Post mortem revealed lobular pneumonia, chronic purulent bronchitis, degenerative changes blood chemistry, kidney function, stress tests, and post mortem pathology and histology same as controls. Weight gain over controls ($p < 0.05$)	174
"	1.4	5.2	24 hrs/day, 61 days	15	Sluggish, weight changes (p less than 0.01), altered motor chronaxy (p less than 0.01), increased blood cholinesterase activity ($p < 0.01$)	17
"	0.03	0.11	24 hrs/day, 61 days	15	Healthy, no weight changes, motor chronaxy changes ($p < 0.01$), increased cholinesterase activity ($p < 0.01$)	17
"	0.003	0.011	"	15	Healthy, no weight change, unaltered motor chronaxy, no change in cholinesterase activity	17

TABLE XII-14

ANIMAL RESPONSES FOLLOWING ORAL ADMINISTRATION OF PHENOL IN WATER

Species	Dose (ppm)	Medium	Observation Time	N	Response
Rat	0-4,000	Drinking water	5 generations	?	No change
"	3,000-5,000	"	"	"	No significant change
"	7,000	"	2 generations	"	Stunted growth in young
"	8,000	"	"	"	Mothers did not routinely care for young
"	10,000	"	1 year	"	Offspring died at birth
"	12,000	"	"	"	No reproduction, premature death in hot weather

From reference 173

TABLE XII-15

PROMOTION OF SKIN TUMORS BY PHENOL IN MALE "S" ALBINO MICE

N	Initiator	Phenol Concentration & Duration	Tumor Production			Survival	Duration of Observation (wk)
			# with Tumors	# with Carcinoma	Total Tumors		
20	None	0.1 ml 5% phenol in acetone, 1/wk, at 2 sites in rotation, 32 wks	0	0	0	18 at 45 wk	45
20	0.2 ml 0.15% DMBA in acetone (300 μg)	"	? 4	? 2	13 9	Not stated 14	13 45
20	"	0.025 ml 20% phenol 1/wk at 4 sites in rotation, 34 wks	?	?	74 (3)*	13 at 37 wk	45
20	None	0.075 ml 20% phenol	?	?	7 (1)**	11 at 45 wk	45

*Carcinoma
**Hemangioma

From reference 175

TABLE XII-16

PROMOTING ACTION OF PHENOL ON DEVELOPMENT OF SKIN TUMORS IN VARIOUS STRAINS OF ALBINO MICE

Strain	Sex	N	Initiator	Promotor	No. Survivors/ Originals	% Survivors with pa	% Survivors with ca	Duration of (wk)
Sutter	M	23	75 μg (0.025 ml of a 0.3% DMBA in benzene	None	21/23	15	5	42
"	F	23	"	2.5 mg, 2/wk (0.025 ml of 10% phenol in benzene)	22/23	95	73	"
"	"	24	None	"	23/24 14/24	17 35	- -	28 52
"	"	19	75 μg (0.025 ml of a 0.3% DMBA in benzene)	None (0.025 ml benzene 2/wk)	-	0	-	20
"	"	?	"	1.25 mg USP phenol, 2/wk (0.025 ml, 5% phenol in benzene)	-	37	-	20
"	"	?	"	1.25 mg USP phenol, 2/wk (0.025 ml, 5% phenol in benzene)	-	52	-	20
Holtzman	"	30	"	None (0.025 ml benzene 1 wk)	28/30	45 -	- 10	36 52
"	"	30	"	1.25 mg, 1/wk (0.025 ml of 5% phenol in benzene)	28/30 -	77 -	- 45	36 52
"	"	30	75 μg (0.025 ml of 0.39 DMBA in benzene)	2.5 mg. 1/wk (0.025 ml of 10% phenol in benzene)	29/30 -	95 -	- 55	36 52
"	"	22	"	0.025 ml of 0.5% croton oil in benzene	21/22	4	-	36
"	"	30	None	1.25 mg, 1/wk (0.025 ml of 5% phenol in benzene)	30/30	3	-	36
				(0.025 ml of 10% phenol in benzene)	-	-	-	52
"	"	30	"	0.025 ml of 0.5% croton oil in benzene	30/30	20	-	36
CAF1	"	20	75 μg (0.025 ml of a 0.3% DMBA in benzene)	2.5 mg, 2/wk (0.025 ml of 10% phenol in benzene)	-	60	21	52
"	"	20	None	"	-	0	0	52
CH3	"	20	75 μg (0.025 ml of a 0.3% DMBA in benzene)	"	-	43	29	52
"	"	20	None	"	-	0	0	52

*pa--papilloma; **ca--carcinoma

From reference 176

TABLE XII-17

PROMOTING ACTION OF PHENOL ON DEVELOPMENT OF SKIN TUMORS IN FEMALE MICE OF THE SUTTER STRAIN

Initiator	Promotor, 2/wk	No. Survivors/ Original	% Survivors with pa*	% Survivors with ca**	Av. Pa Survivor	Duration of Observation (wk)
75 µg (0.015 ml of 0.3% DMBA in acetone)	5 mg (0.025 ml of 20% phenol in acetone)	21/24	58	5	-	12
"	None (0.025 ml benzene)	12/12	0	0	0	12
"	5 mg (0.025 ml of 20% phenol in benzene)	22/27	64	0	1.50	12
None	None (0.025 ml of benzene)	27/32	11	0	0.15	24
	1.25 mg (0.025 ml of 5% phenol in benzene)	27/33	74	4	1.67	24
"	2.5 mg (0.025 ml of 10% phenol in benzene)	10/33	100	26	3.94	40
"	5 mg (0.025 ml of 20% phenol in benzene)	15/33	100	93	3.70	39
75 µg (0.025 ml of 0.3% DMBA in acetone)	1.25 mg (0.025 ml of 5% phenol in benzene)	25/33	56	70	1.16	38
"	2.5 mg (0.025 ml of 10% phenol in benzene)	19/33	95	12	2.68	40
75 µg (0.025 ml of 0.3% DMBA in acetone)	5mg (0.025 ml of 20% phenol in benzene)	20/33	90	68	2.25	39
None	5 mg (0.025 ml of 20% phenol in dioxane)	16/30	63	0	0.94	12
"	2.5 mg (0.025 ml of 10% phenol in benzene)	24/30	33	29	0.62	28
75 µg (0.025 ml of 0.3% DMBA in acetone)	2.5 mg (0.025 ml of 10% phenol in acetone)	19/20	32	0	0.63	16
"	None (0.025 ml of acetone)	18/20	0	0	0	16
"	2.5 mg (0.025 ml of 10% phenol in benzene)	16/20	88	0	2.62	12
"	None (0.025 ml benzene)	18/20	0	0	0	12
"	"	18/20	0	0	0	20
"	1.25 mg (0.025 ml of 5% phenol in benzene)	13/19	31	8	0.46	20
"	2.5 mg (0.025 ml of 10% phenol in benzene)	12/20	83	8	2.08	20
0.25 µg (0.025 ml of 0.1% DMBA in acetone)	None (0.025 ml of 30% ethanol in acetone)	20/20	0	0	0	14
"	0.025 ml of 9.4% (1m) in 30% ethanol in acetone	19/20	16	0	0.26	14

pa—papilloma; ca—carcinoma

From reference 176

TABLE XII-18

PROMOTION OF SKIN TUMORS BY PHENOL IN FEMALE MILLERTON MICE

N	Initiator	Promotor	Cumulative with pa*	Cumulative with ca**	# surviving	Duration of Observation	References
30	75 μg DMBA in acetone	None	10	7	17	15 mo	177
30	None	5% phenol in acetone 3/wk	-	-	21	"	177
28		10% phenol in acetone 2/wk	7	3	16	"	177
30	75 μg DMBA in acetone	5% phenol in acetone 3/wk	33	10	17	"	177
30	"	10% phenol in acetone 2/wk	87	70	4	"	177
30	"	10% phenol in acetone 3/wk	80	47	3	"	177
40	5 μg Bap, 0.005% in acetone, 3/wk	None	70	68	2	"	177
28	"	5% phenol in acetone 2/wk	83	77	0	12 mo	177
28	"	10% phenol in acetone 2/wk	80	70	0	"	177
20	150 μg DMBA in 0.1 ml acetone	None	2	1		52	178
20	"	3 mg phenol in 0.1 ml acetone, 3/wk, 52 wks	4	1		"	178
20	5 μg BaP in 0.1 ml acetone 3/wk, 460 days	3 mg phenol in 0.1 ml acetone, 3/wk, 460 days	3	1		460	179
20	"	None	8	1		"	179

*pa--papilloma
**ca--carcinoma

TABLE XII-19

EXISTING STANDARDS FOR PHENOL

Country	Standard			References
	mg/cu m	ppm	Type	
USA 1) Federal standard	19	5	TWA (skin)	FR 39 (125) 1974
2) ACGIH recommendation	19	5	TWA (skin)	129
Bulgaria	5	--	Ceiling	349
Czechoslovakia	20	5	"	320
"	40	10	Peak	320
Federal Republic Germany	19	--	Ceiling	349
Finland	19	5	"	349
German Democratic Republic	19	--	"	349
Hungary	5	--	"	349
Poland	5	--	"	349
Rumania	5	--	"	349
USSR	5	--	"	349
Yugoslavia	19	5	"	349
USA - Florida	--	5	"	349
- Mississippi	--	5	"	349
- Pennsylvania	--	5	"	349
- South Carolina	--	5	"	349

TABLE XII-20

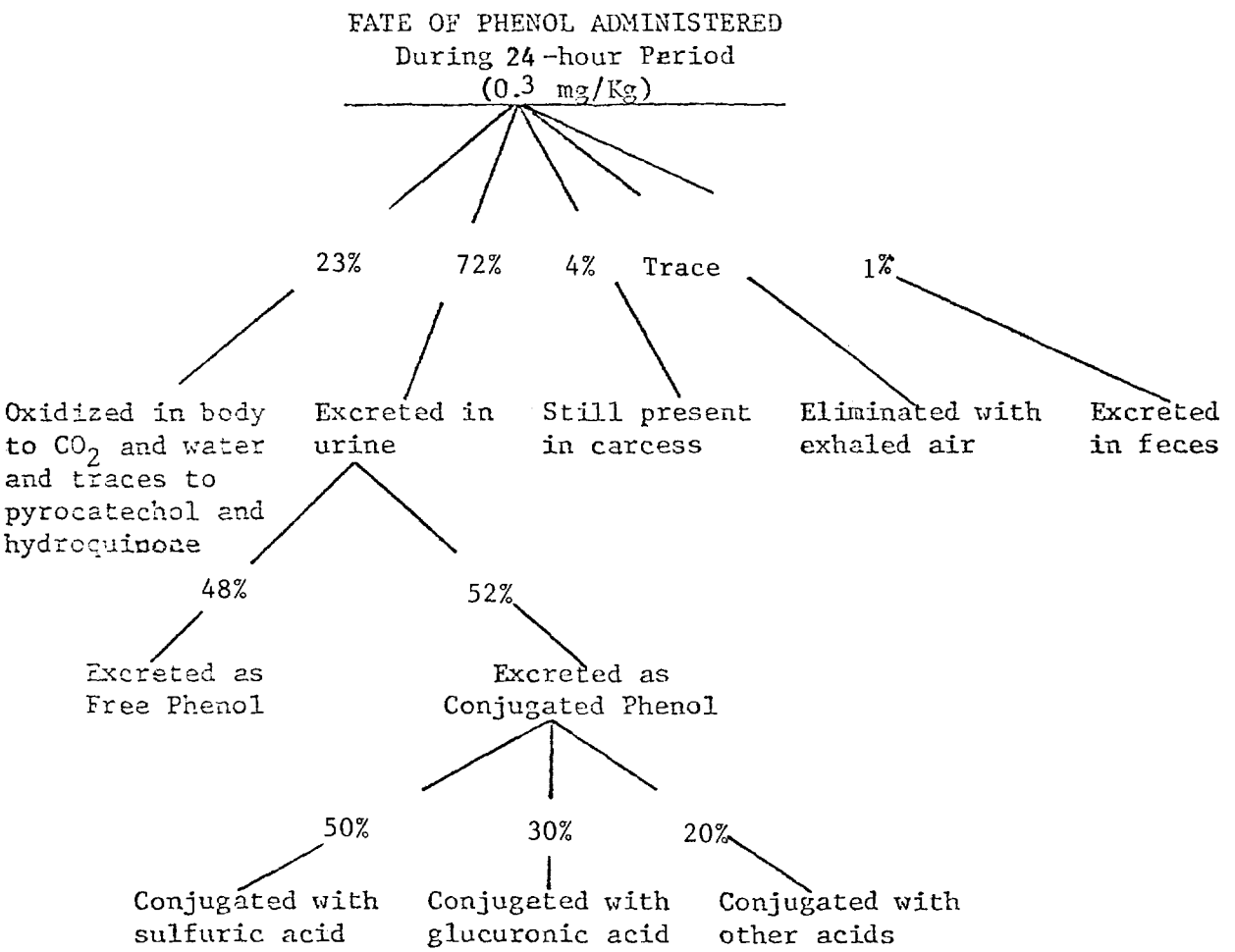
VALUES PRESENTED BY CZECHOSLOVAK COMMITTEE OF MAC

Author	Year	mg/cu m	Basis
Lazareff	1959	4	Smell
Smyth	1956	19	Suggestion for MAC
Bardodej	1960	20-30	Distinct smell; no damage was observed
Patty	1949	29	Smell
Deichmann	1944	100-200	Lung damage in guinea pigs after 20 days, in rabbits after 63 days; no damage noted in rats.

From Documentation of MAC in Czechoslovakia [320]

FIGURE XII-1

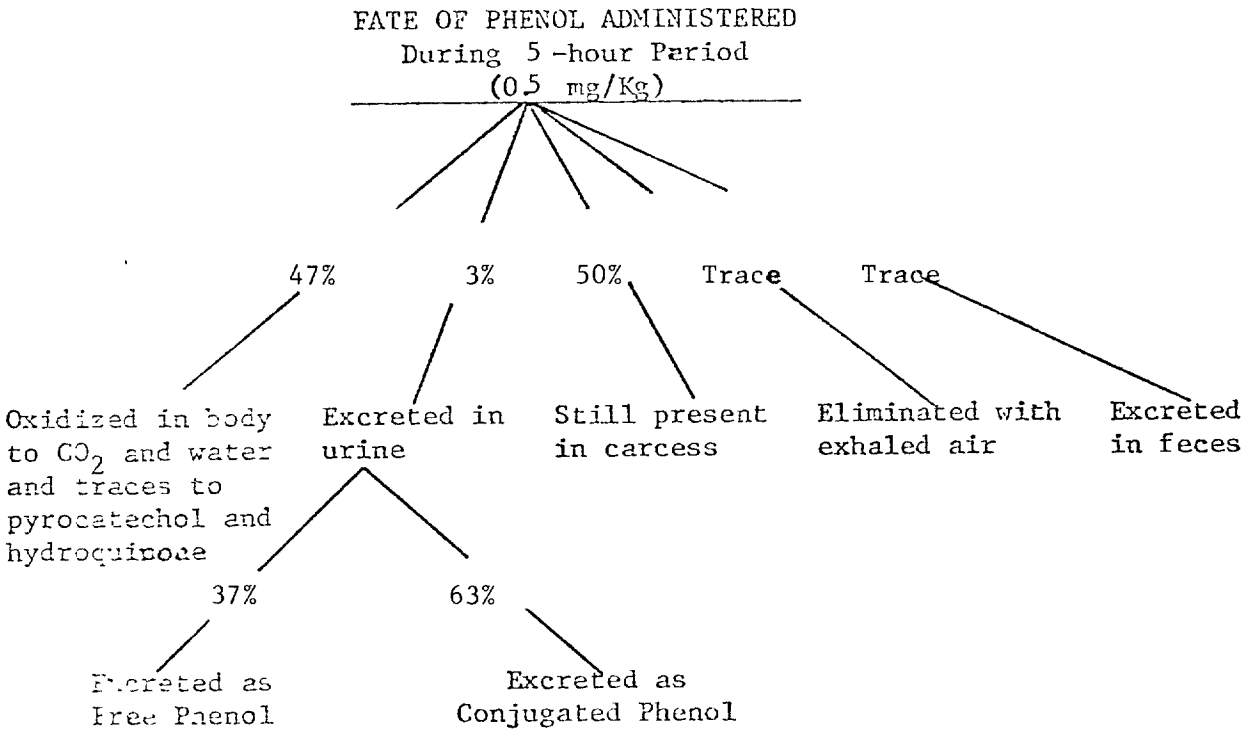
FATE OF PHENOL IN A RABBIT GIVEN A SUBLETHAL ORAL DOSE ADMINISTERED DURING 24-HOUR PERIOD



From Deichmann and Keplinger [196]

FIGURE XII-2

FATE OF PHENOL IN A RABBIT GIVEN A LETHAL ORAL DOSE ADMINISTERED DURING 5-HOUR PERIOD



From Deichmann and Keplinger [196]

☆U S GOVERNMENT PRINTING OFFICE 1977— 757-057/5731

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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HEW 399

HEW Publication No. (NIOSH) 76–196