Livestock Poisoning From Oil Field Wastes

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As a result of the close proximity of cattle to oil exploration and production activities in Oklahoma, the Oklahoma Animal Disease Diagnostic Laboratory is frequently called upon to investigate cases involving oil field related poisonings.

Potential hazards exist in livestock and wildlife in all of the following aspects of the oil industry. During exploration, discarded chemicals are potential hazards. During drilling operations, drilling muds, salt water, crude oil, caustic chemicals, acids, and heavy metals may constitute a hazard to livestock and wildlife in the vicinity. During production, crude oil, salt water, and slushpit materials have all been incriminated as causes of poisoning.

During transportation, hazards exist from pipeline breaks and chemicals used to maintain pipelines. The refinery phase although closely regulated may, through accident or carelessness, result in contamination of land and water from various effluents and emissions.

One of the most difficult problems confronting the practicing veterinarian is the diagnosis of poisoning from oil field wastes particularly from crude oil, condensates and other petroleum hydrocarbons.

Clinical reports have been published on petroleum intoxication in ruminants. The circumstances as to why these animals ingest crude oil and other petroleum products are varied. It appears that ruminants ingest crude oil and petroleum products when thirsty and water is not readily available, when food or water is contaminated with petroleum, when seeking salt or when being grazed on poor quality pasture. Cattle are curious and feeder calves seemingly ingest petroleum in an attempt to provide an exotic variety to their diets.

Crude oil is a mixture of several hundred different chemical compounds. The composition of crude oil varies with the reserve from where it is produced, with weathering and other factors. Weathering may remove the more volatile and water soluble components.[1] This variation in crude oil composition may explain some of the variation seen clinically since acute clinical signs seem to be related to the more volatile fractions.[4,5]

Clinical signs in a herd that has been known to ingest crude oil, condensate and other petroleum hydrocarbons varies from sudden death to no observable effects. Onset of clinical signs encountered are petroleum smell on the breath, hyperesthesia, hypoesthesia, anesthetic like depression, mydriasis, ptyalism, epiphora, muscle tremors, head tremors, ataxia, tonic-clonic convulsive seizures, hypothermia and hyperthermia. Gastrointestinal signs include vomiting, bloat, rumen atony and abomasal displacement. Inhalation pneumonia is reported as a common sequela to ingestion of petroleum hydrocarbons. Fluid feces with a petroleum smell, diarrhea, constipation and hard oily feces have all been observed. Cardiopulmonary signs of tachycardia, hyperpnea, dyspnea, and moist rales have been observed. Ketonemia, ketonuria, albuminuria, leukopenia, eosinophilia, hypomagnesemia, and elevated serum glucose have been documented.[3,4]

Crude oil has been found to destroy rumen flora and the enzymatic actions of rumen fluids.[2] Crude oil may also inhibit the absorption of fat soluble vitamins.

Necropsy findings are varied. Most gross pathological changes occur in the lungs, liver, rumen wall, abomasum, intestine, kidneys and urinary bladder. To diagnose petroleum toxicity the source of the toxicant must be identified. Detection of petroleum in solvent extracts of rumen and intestinal contents, liver, lungs and kidney by laboratory analysis is helpful. The identity of the petroleum in the ingesta and tissue extracts can be matched to that of the source. Positive correlation confirms a field diagnosis.

The potential for litigation exists whenever cattle in close proximity to drilling and production sites become ill or die. Many of these cases could be prevented if livestock were prevented access to such sites by fencing or other means.

A diagnosis cannot be made on the basis of circumstantial evidence alone. Many cases were oil field wastes are suspected as a cause of illness or death have turned out to be other disease and management problems. This emphasizes the need for a complete postmortem examination and diagnostic workup. Improved diagnostic methods and analytical procedures should benefit both the livestock and oil industries.

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During 1977, the Oklahoma Animal Disease Diagnostic Laboratory investigated 44 cases of suspected oil field related poisonings. There were 2459 cattle exposed of which 527 were sick and 203 were dead. Drilling activity in Oklahoma for 1977 involved 4,976 oil and gas well completions.

During 1978, 80 cases of suspected oil field related poisonings were investigated, 29 of which involved petroleum hydrocarbons such as condensate and crude oil. The remaining 51 cases involved salt water, heavy metals, caustic chemicals or other causes of disease. Drilling activity in the state for 1978 involved 5899 oil and gas well completions.[6]

Table 1 summarizes those cases where petroleum hydrocarbons were identified as the probable cause of illness or death following exposure.

The following analytical procedure was developed to identify petroleum hydrocarbons from suspect materials and tissues and aid in the diagnosis of poisoning from oil field wastes.[7]

Materials:

1) Freon 113 (1, 1, 2--trichloro--1, 2, 2--trifluoroethane) E.d. Dupont de Nemours, Inc.
2) Florisil 60-100/PR (Magnesium Silicate activated at 1250°F) Sigma Chemical Co.
3) Sodium Sulfate, anhydrous, reagent grade.
4) Waring Blender.
5) Gas-chromatograph: Perkin-Elmer 3920B equipped with flame ionization detector.

Method:

Samples of water, rumen contents, abomasal contents, feces, and lung tissues have been evaluated for petroleum content. Petroleum hydrocarbons, especially the more volatile fractions, appear to accumulate in the abomasum and, in cases where aspiration occurs, the lung.

Ten to fifty grams of sample was extracted with an equal volume of Freon 113 in a waring blender at high speed for 2 minutes and filtered through solvent washed glass wool. The Freon fraction was then passed through a clean-up column

Table I
1978 Cases Involving Petroleum Hydrocarbons

Case	No. In Herd	No. Sick	No. Dead	Material	Comments
1	150	4	3	Condensate	Petroleum Hydrocarbons confirmed in rumen contents and lung tissue.
2	80	?	2	Condensate	Approximately 2% by volume of the rumen contents were petroleum hydrocarbons. Animals were ataxic and had diarrhea.
3	29	?	1	Condensate	Material from broken pipeline. Rumen contents contained greater than 1% petroleum hydrocarbons.
4	400	?	18	Crude Oil	Petroleum hydrocarbons detected in rumen contents.
5	111	3	1	Condensate	Material from slushpit identified as a petroleum hydrocarbon.
6	127	5	1	Condensate	Petroleum hydrocarbons confirmed in rumen contents.
7	200	5	25	Condensate	Material from puddles on ground identified as a petroleum hydrocarbon.
8	58	17	9	Condensate	Petroleum hydrocarbon confirmed in rumen and abomasal contents and in lung.
9	135	18	0	Condensate	Rumen contents were 8% petroleum hydrocarbon. Material not confirmed in lung tissue.
10	50	0	1	Crude Oil	Petroleum hydrocarbon confirmed in rumen contents, feces, and lung tissue.
11	15	0	1	Crude Oil	Petroleum hydrocarbon detected in nasal fluid, rumen contents and lung tissue.

of 4 inches of Florisil deactivated with 5 ml. of distilled water. The elutant was dehydrated with anhydrous sodium sulfate.

In order to maintain the more volatile hydrocarbons the solvent was not concentrated and chromatographic analysis was accomplished as soon as possible after extraction.

Three to 5 microliters of sample was injected onto the chromatograph column packed with 10% carbowax 20M on 80/100 mesh Supelcoport. Chromatograph conditions were:

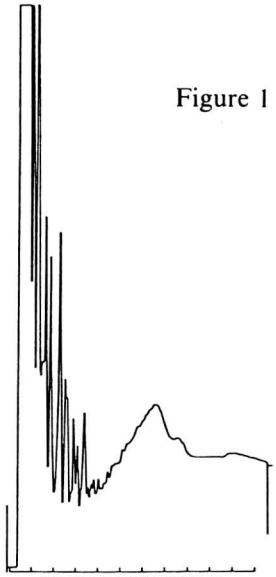
Initial Temp. 100°C	Injector Temp. 200°C
Final Temp 190°C	Interface Temp. 200°C
Rate 32°/min.	Final Time 8 minutes
Amplifier Range x 10	Attenuation x 128

Analysis of Chromatographic Data:

The procedure of matching chromatographic tracings of multiple peak samples is known as "fingerprinting". Each petroleum product and crude oil is characterized by its own unique set of compounds and compound concentrations. Chromatographically each detectable component is represented by a distinct and separate peak. The product's fingerprint is the accumulation of all its peaks.

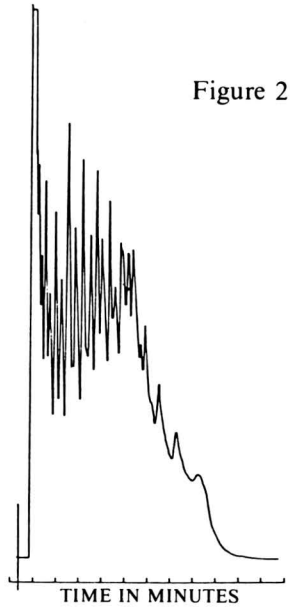
The predominant petroleum compounds detected by this procedure are series' of alkanes and alkenes. Four distinct types of petroleum fingerprints are commonly associated with oil field toxicity cases. They are represented in figures 1-4. The petroleum product in figure 1 is a condensate or "drip gas". Figure two is characterized by a predominance of less volatile hydrocarbons and is probably a distillate. Figure 3 represents a typical crude oil and fig. 4 a weathered crude.

Figure 1



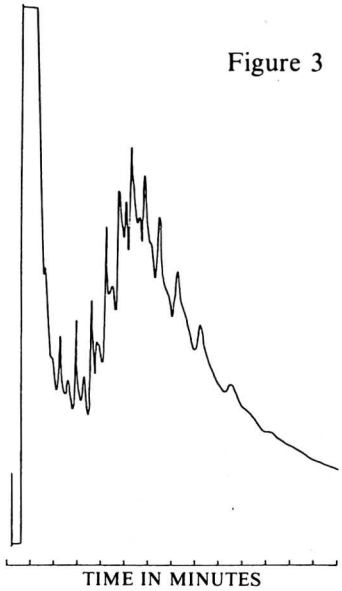
condensate

Figure 2



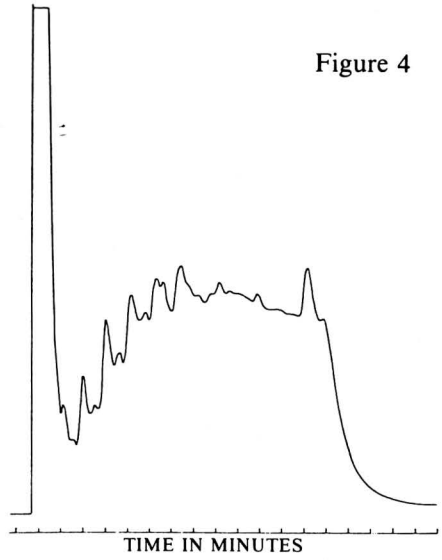
distillate

Figure 3



typical crude oil

Figure 4



weathered crude oil

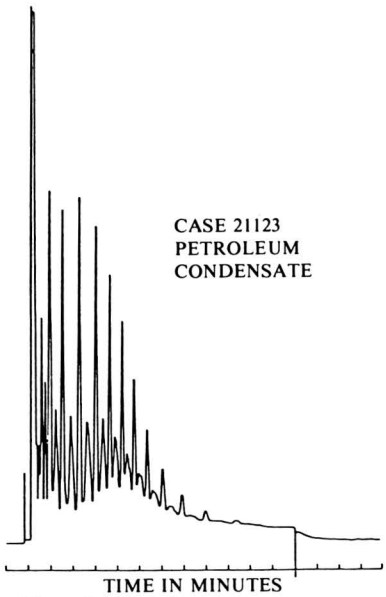


Figure 5

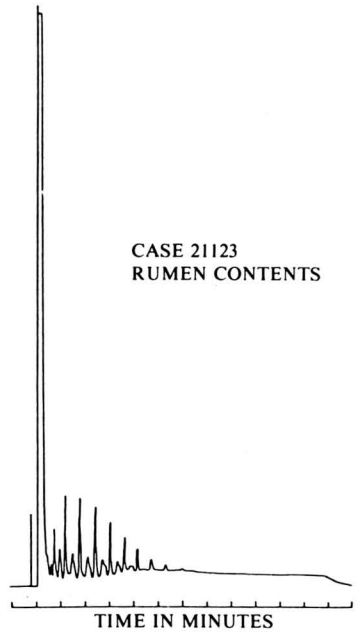


Figure 6

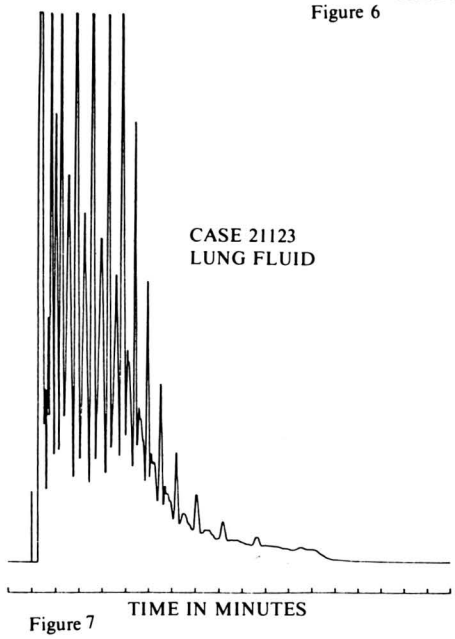


Figure 7

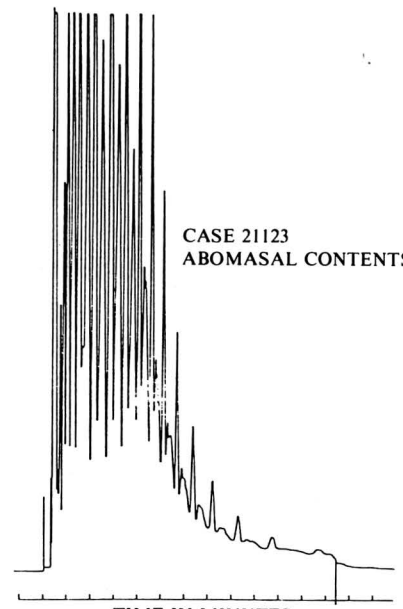


Figure 8

The shorter the retention time of a petroleum compound the nearer to the left of the figure it appears. In figures 3 and 4 the petroleum packet appears. It is the large homogenous peak upon which the other peaks are superimposed. All crude oils and weathered crude oils are characterized by this petroleum packet.

A typical case involved 58 yearling steers that had access to a petroleum distillate which leaked from a tank. Seventeen of the steers became ill and 9 died. Several of the animals had distillate draining from the nose. The chromatograms of the condensate material matched residues from the rumen and abomasal contents and lung tissue (Figures 5-8). Clinical signs varied from deaths to anorexia and weight loss in the surviving cattle.

References

1. Reed, W. E., Molecular Compositions of Weathered Petroleum and Comparison with Its Possible Source. Geochemical Cosmochimica Act. 41: (1977) 237-247. - 2. Eaton, G., Paraffin Poisoning in Cattle. Veterinary Record 55: (1943) 19. - 3. Parker, W. H., Williamson, T. F., Parraffin Poisoning in Cattle. Veterinary Record 25: (1951) 430-432. - 4. Rowe, L. D. Dollahite, J. W., Camp, B. J., Toxicity of Two Crude Oils and of Kerosene to Cattle. Journal of American Veterinary Medical Association 162: (1973) 61-66. - 5. Stober, M., Toxicity for Cattle of Crude Oil and Heating Oil. Dtsch. tierarztl. Wschr. 69: (1962) 386-390. - 6. The Oil and Gas Compact Bulletin. Interstate Oil Compact Commission Vol. XXXVI, no. 1, June, 1978. Pages 38-39. - 7. Zinn, L. L. and Edwards, W. C., Rapid Qualitative Procedure for the Identification of Petroleum Products in Animal Tissues by Gas Liquid Chromatography Bul. Environm. Contam. Toxicol. 22, 285-286 1979).