South African Mr. L. J. Fry has used this plant for over 15 years to collect inflammable gas from animal waste. The gas powers a converted diesel engine, heat from which is recycled to maintain the temperature in the manure digestion tank.

GAS FROM WASTE—1

Turning Droppings Into Gas

● Scattered around the world are a handful of farmers whose poultry manure, far from representing an ever-increasing disposal problem, is regarded as a much-valued commodity. For these pioneers have installed facilities to transform much of the carbon and hydrogen contained in poultry waste into methane gas, in sufficient quantities to keep the farm supplied with home-produced power for all its heating and lighting needs.

Generating gas from manure is not a new idea. In China and other parts of Asia it has been widely practised for decades, even if only in small-scale plants, while in South Africa one farm at least has met all its power requirements from a manure-gas plant for over 15 years. What has focused renewed attention on the idea is, of course, the present energy crisis.

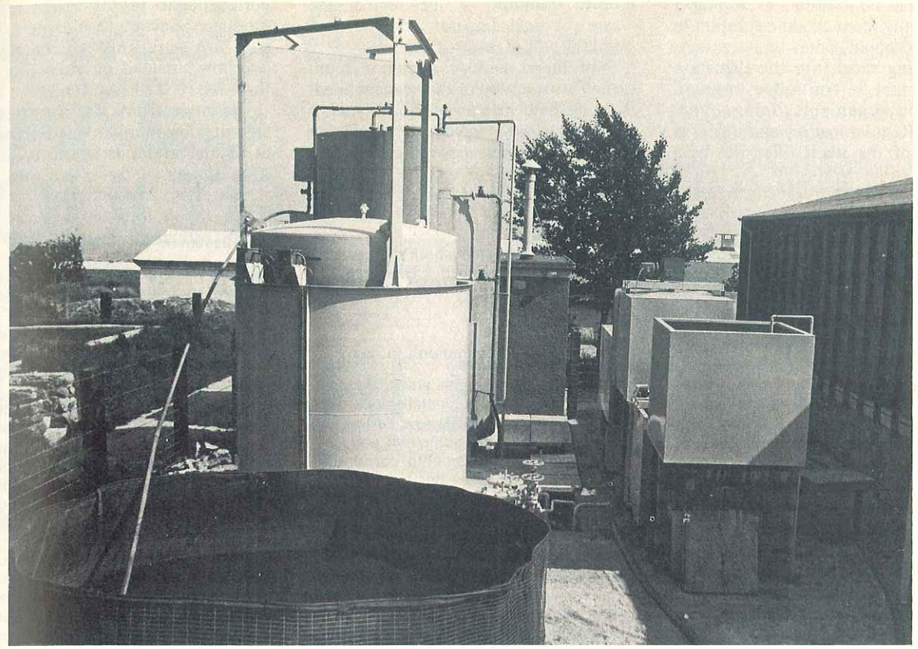
Simple Process

In principle, turning droppings into gas is a fairly simple process. All that is needed is to expose manure to the digesting action of anaerobic bacteria, and collect the gas — mainly methane, with some carbon dioxide — given off as a byproduct of the degradation of organic matter. Yet it still involves some degree of experimentation to construct a gas generator which is capable of operating efficiently over a long period of time.

In some latitudes, temperature can be a constant problem. For bacterial action is most productive, in terms of gas output, at a temperature of about 35°C. In countries where the average daily temperature does not stay around this level all the year, some sort of external heating may be necessary for the generator. Therefore a balance must be found between the cost of energy for heating to support the process, and the value of the energy derived from it.

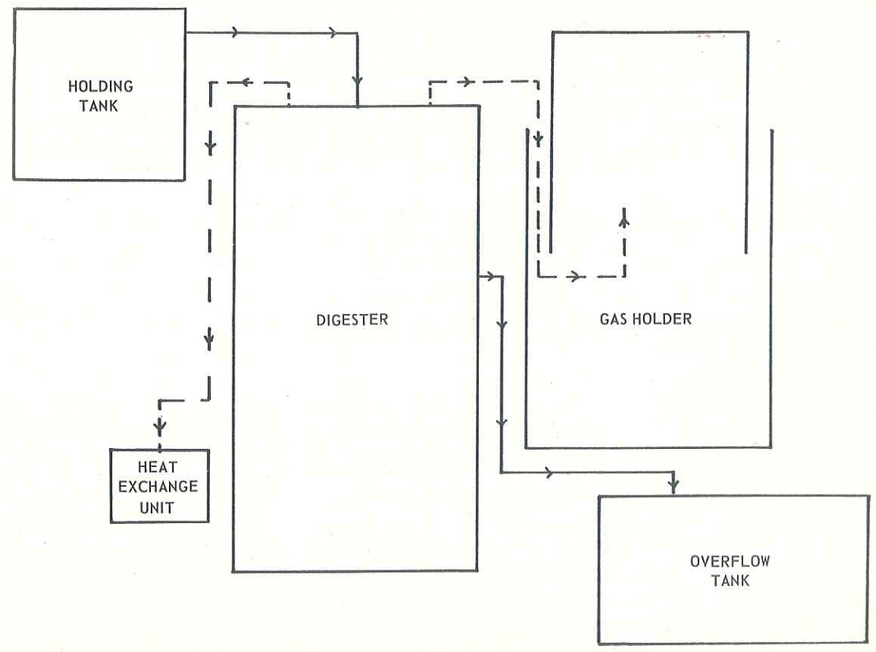
The microbes also need to be treated carefully in other respects if they are to

(Continued on page 10)



This photograph and diagram show the equipment used by Scottish researchers to produce gas from manure. Gas from the digester is burned in a heat exchange unit to warm the digester. (Photograph by courtesy of Scottish Farm Buildings Investigation Unit)

Turning Droppings Into Gas



work effectively. For instance, they do not like acid conditions, so adding a small quantity of an alkaline solution to the stored droppings may be necessary. Also, loading rates into the digestion chamber must be controlled to guard against the organisms being overwhelmed. Regular loading and uniform operation of the plant offer the best chance of achieving a predictable gas output, optimum purification of the waste for final disposal, and the least possibility of digester failure.

With liquid manure, a crust of scum often forms on top of the waste while it is being held in a store. But if such a crust developed inside the digestion tank it would seriously interfere with the gas-generating process. Being impermeable to gas, it would force the methane and carbon dioxide to escape with the liquid through the digester's overflow, instead of collecting above the surface of the contents.

Of course, fitting a stirring device inside the digestion tank and activating it at regular intervals would ensure that

Kotumwandlung in Gas

Zusammenfassung—In verschiedenen Ländern haben einige Produzenten Anlagen aufgebaut, um Geflügelabfälle in Methangas zu verwandeln und zwar in solchen Mengen, dass dadurch der Eigenenergiebedarf für Heizung und Beleuchtung gedeckt werden kann.

Um Kot in Gas zu verwandeln, braucht man diesen nur der zersetzenden Tätigkeit anaerobischer Bakterien auszusetzen und das Gas, hauptsächlich Methan (und etwas Kohlendioxyd) aufzufangen. Das Gas wird als Nebenprodukt der organischen Zersetzung abgegeben. Dennoch ist ein gewisses Mass an Experimentierung erforderlich, um einen Gasgenerator zu bauen, der über zufriedenstellend lange Zeit funktionstüchtig ist.

Eine typische Kotzersetzungsanlage besteht aus einem Kotbehälter, einem sogenannten Digestertank, in dem die Zersetzung vor sich geht, und einem Gasbehälter. Der Digester hat einen Flüssigkeitsüberlauf, ist gut isoliert (damit die Innentemperatur erhalten bleibt) und oben hermetisch abgedichtet, um alles erzeugte Gas aufzufangen. An einem typischen Gasbehälter befindet sich oben eine glockenförmige Haube, in die das Gas hineinströmt, und die sich mit steigendem Volumen anhebt, so dass der ungefähr vorhandene Gasvorrat direkt sichtbar ist.

Der Kot aus der Lagergrube wird mit etwas Wasser vermischt und mehrmals täglich in den Digester gepumpt. Sobald eine neue Charge in den Tank eingepumpt wird, wird eine entsprechende Menge zersetzten Materials abgeführt. Das Gas wird direkt von der Oberseite des Digesters in den Gasbehälter gepumpt. In gewissen Zeitabständen müssen die Feststoffreste aus dem unteren Teil der Zersetzungskammer entfernt werden, während die behandelte Flüssigkeit in den Überlauftank gelangt.

Ca. 50% des ursprünglichen Abfallvolumens sind letztlich als Restabfall zu beseitigen. Diester Rest ist schwarz und hat eine sirupähnliche Konsistenz; er ist geruchsfrei und bildet keine Niststätte für Fliegen. Er enthält allerdings noch einen Grossteil des ursprünglichen Düngewertes und kann also als Düngemittel eingesetzt werden.

Das erzeugte Gas besteht bestenfalls aus ca. 75% Methan und 25% Kohlendioxyd, es ist entzündbar und kann zur Luft- oder Wassererhitzung oder als Treibstoff für einen Gasmotor, der elektrischen Strom erzeugt oder direkt als Antriebsquelle gebraucht wird, verwendet werden. Aus einem Kilogramm Geflügelkot können 25 1 Gas erzeugt werden.

Conversione di escrementi in gas.

Riassunto—In vari paesi alcuni produttori hanno costruito installazioni per trasformare immondizie avicole in gas metano, in quantità sufficienti per approvvigionare l'allevamento con energia prodotta in casa—per tutte le necessità di riscaldamento ed illuminazione.

Per convertire escrementi in gas basta esporre escrementi all'azione di fermentazione dei batteri anaerobici e raccogliere il gas—essenzialmente metano con un po' di anidride carbonico—prodotto come derivante di una degradazione di una sostanza organica. Occorrono, comunque, certe richerche per costruire un generatore di gas, in grado di funzionare efficientemente durante un lungo periodo.

Un impianto tipico di fermentazione di escrementi consiste in un recipiente per gli escrementi, una cisterna come digestore ed un contenitore per il gas. Il digestore possiede un troppo-pieno per i liquidi, é ben isolato per mantenere la temperatura interna ed é ermeticamente chiuso in cima per tenere tutti i gas prodotti. Il contenitore tipico ha un coperchio a forma di campana, nel quale il gas entra e che si alza con il volume; la quantità di gas accumulato, quindi, puo' essere verificato immediatamente.

Escrementi, provenienti dal recipiente, vengono mescolati con un po' d'acqua e pompati nel digestore parecchie volte al giorno. Quando il nuovo carico entra nella cisterna, scarta una quantità equivalente di materiale usato. Direttamente dalla cima del digestore il gas viene pompato nel contenitore. Di tanto in tanto il resduo dei solidi deve essere tolto dal fondo, mentre il liquido trattato aspetta di essere evacuato nel troppo-pieno.

Circa il 50% del volume d'origine dei solidi deve essere trattato, a suo tempo, come residuo. La sostanza é nera e sciropposa, inorore e non attira le mosche. Pero' mantiene il suo valore come concime nell'agricoltura.

Il gas migliore contiene circa 75% di metano e 25% di anidride carbonico, é infiammabile e puo' essere utilizzato per riscaldare aria o acqua o per far funzi onare una macchina a gas, e per la produzione di energia elettrica o meccanica. 1 kg. di escrementi di polli puo' generare 25 litri di gas.

Convertissement du Jumier en gaz.

Sommaire—Quelques producteurs dans plusieurs pays ont installés des facilités nécèssaires pour convertir le fumier de volailles en gaz méthane, en quantité suffisante pour produire assez de gaz pour le chauffage et l'éclairage de la ferme.

Pour convertur le fumier en gaz, tout ce qui est nécéssaire, est de l'exposer a l'action digestive des bactéries anaérobiques, et récolter le gaz surtout méthane, avec une certaine quantité de dioxide de carbone- formé par un sous produit de la dégradation des matières organiques.

Cependant cela demande encore un certain degré d'expérimentation pour construire un générateur de gaz qui est capable d'oper er éfficassement pendant une période de temps prolongeé.

Une installation typique de digestion de fumier consiste d'un réservoir pour le fumier, un tank qui agit comme digestateur, et un recipient pour le gaz. Le digestateur a un tuyau de trop plein pour le liquide, il est bien isolé pour maintenir la température interne et est scellé sur le dessus pour emprisonner le gaz produit. Un type de récipient ordinaire a un couvercle en forme de cloche dans lequel le gaz bouillonne et s'élève quand le volume augmente, pour permettre de voir la quantité approximative déja obtenue.

Le fumier du réservoir est mélangé avec un peu d'eau et pompé plusieure fois par jour dans le digestateur. Quand le nouveau chargement entre dans le tank, il déplacè une quantité similaire de matiére employeé. Directement du dessus du digestateur, le gaz est pompé dans le récipient. A interval un résidu de solides doit être retiré de la base de la chambre, pendant que du liquide traité attend d'être enlevé du tank de trop plein.

A peu près 50% du volume original du total des solides doit éventuellement être enlevé comme résidu. C'est noir et comme du syrop en consistence, N'a pas d'odeur et n'attire pas les mouches. Mais il retient une grande partie de sa valeur comme fertilisateur pour les récoltes. Le meilleur gaz consiste a peu près de 75% de méthane et de 25% de carbone dioxide, il est inflammable et peut être brulé pour chauffer de l'eau ou de l'air, ou pour activer un moteur a gaz qui produit une force électique ou mécanique Un kg de fumier de volailles peut produire 25 l litres de gaz.

no crust could form. But, once again, the power requirement for turning the agitator would have to be taken into account when calculating the value of the plant.

Air Leaks Dangerous

Safety is another factor which must be studied closely during the planning stage. In particular, there must be no leaks in the apparatus which would allow gas to escape, or air to enter the system.

Fortunately, the gas produced by manure digestion is not dangerous if inhaled in small amounts, burns with a violet or blue flame and does not give off a heavy odour. The quantities it contains of ammonia and hydrogen sulphide are usually negligible. But care is still needed because mixtures of methane and air can explode violently if ignited.

Although air is unlikely to leak into the plant in large enough quantities to cause an explosion, small-scale leaks could lead to the gas produced being almost worthless. This would happen if the nitrogen in the air diluted the methane. So regular checks for damaged or defective valves and pipes are most important.

Perhaps surprisingly, it is not always possible to forecast accurately just how much gas will be produced from a given quantity of poultry manure. A figure of 25 litres of gas from each kilogram of manure has been quoted, but actual production is found to vary according to the amount of organic material present in the manure at the outset, how long the waste stays in the digester and how high the operating temperature is. Mixing droppings before they are fed into the digester is sometimes necessary to provide a more uniform raw material.

A typical manure digestion plant consists of a holding pit or reservoir for the droppings, a tank to act as the digester, and a gas holder. The digester has an overflow for the liquid, is well insulated to maintain internal temperature and is sealed at the top, to trap all the gas produced. A common type of holder has a bell-shaped cap into which the gas is bubbled and which rises as the volume increases, so that the approximate amount in store can be readily seen. It must have facilities for relieving pressure, either in the form of a valve to release excess gas into the atmosphere or a means of burning it off.

Droppings from the pit are mixed with a little water and pumped several times every day into the digester. As the new load enters the tank, it displaces a similar amount of used material.

Directly from the top of the digester, gas is pumped into the holder. At intervals, a residue of solids must be removed from the base of the chamber, while treated liquid awaits disposal in the overflow tank.

Fertiliser Residue

About 50% of the original volume of total solids must eventually be handled as a residue. It is black and syrup-like in consistency, is odourless and is unattractive to flies. But it retains much of its value as a fertiliser for application to crops.

Although the solids in the digestion chamber settle out relatively easily, a proportion remain in suspension in the liquid from the tank. This liquid is therefore light brown in colour and, again, odourless. Compared with the original effluent, it shows an 80% reduction in BOD (Biological Oxygen Demand — a measurement of polluting power). However, it is still too potent for direct discharge into rivers or watercourses, although it can be accepted into domestic sewers at relatively low cost.

What of the gas produced? At its best its composition will be about 75% methane and 25% carbon dioxide, it is inflammable and can be burned to heat air or water or to drive a gas engine supplying electrical or mechanical power. If we take the estimate of 1 kg poultry manure being enough to generate 25 litres of gas, this is roughly equal to 131 kilogram-calories in usable power. About 2500 kcals are needed per engine brake horsepower per hour, which represents the energy produced by digesting one week's production of droppings from 90 layers or just over 80 broilers.

Prices for other forms of fuel and the cost of other forms of manure disposal will dictate whether gas production from droppings is an economical proposition. However, at the least the process offers a useful by-product from the treatment of manure before disposal.

— Peter Best