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An Investigation of the Effects of Direct Ground Liquid CO_2 Injection on Soil Synthetic Characteristics in Areas with Deep Buried Geological Environment

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ABSTRACT

To depict the influence of a significant Carbon dioxide concentration upon that soil in the mining operations subsidence area, the ground well above goaf preceding CO2 introduction is utilised as a deflation zone model. CO2 diffusion in the goaf is thought to be a narrow high Carbon dioxide leakage model based on current vertical depths of 80–90 m in shallow underground coal seam geological conditions. Soil surface samples were gathered throughout the observations of 80 tonnes of liquid CO2 administered intravenously. The adjustments in pH and mineral content of the soil can be directly measured at different time interval among CO2 injections by analyzing the distinction in five variables of ground aerosol and spotless snippet, which include pH, nutrient elements, accessibility potassium, water-soluble sodium, and total organic carbon. This demonstrates how injecting CO2 into such a goaf alters the chemical characteristics of the soil around it.

Keywords: CO2, Coal mining, Chemicals, Mining, Soil

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INTRODUCTION

In the research and study of soil chemical features in deflation zones, mainly academics explore the influence of deflation on soil characteristics by analyzing soil nutrients. As a by product of the collapse's irregular ground and surface fissures, fertilisers migrate towards the goaf or low-lying parts, culminating in an inhomogeneity variation in soil nutrients and severely harming plant growth in the collapsed area. Nitrogen, phosphorus, and potassium are the most important indicators of soil nutrients, and they have an impact on soil fertility.

Due to a high number of cracks in the upslope point, there is a significant removal of water and fertilizer, and also the soil minerals are the least. The nutritional composition of the collapse center differs from that of the upslope point. Whenever the crash depth is small, the nutritional shortage in the collapsing core is only temporary. When the depth of the subsidence is significant, the water carries the soil nutrients from the upper and middle slopes to the core of the subsidence, caused by soil nutrient enrichment. If fractures emerge in the midway slope and the fissures are large, the fast-acting minerals that migrate from the top of a mountain to the bottom will be disturbed and lost [1]. The soil, as can be seen from the above, is a continuous inhomogeneity and difference. Soil distribution in nature is very complicated. Various characteristics of the soil show noticeable variations in different spatial locations, even in a region with the same soil texture [2].

The vadose zone is an area beneath the plunging level being above the water's surface. Instead of being inundated with water, the gaps here between soil and rocks in this zone are filled with air. Gasses groundwater, absorbing water, trans membrane water, and micro vascular water are the four fundamental forms of freshwater found in the aeration zone. Gravity water may arise momentarily when rainfall or surface water seeps. The features of soil in the aeration zone have received minimal attention due to high-concentration CO_2 intrusion. They reported that increased CO_2 concentrations had no impact on agricultural production pH of buckwheat and sorghum crops, or on soil particles or soil ions governed by acid-base equilibrium, but had a greater effect on available n, currently offered potassium, organic compounds, and exchangeable cations [3].

In fact, already when Carbon dioxide is released, the outer layer just above mining process area can be deemed a crumbling area model; CO_2 dispersion in the mining process area can indeed be divided into short elevated CO_2 leakage model; and also because the 's perspectives depth is 70 m80 m, it classified as belonging to shallow buried coal deposits. As a result, the two models can be used to evaluate soil samples [4].

REVIEW OF LITERATURE

According to Yinli Bi, both knife technique and a double infiltrometer were used to assess the effects of mining activities on soil physical properties in fishing towns with three different plant species. At the Shendong Bulianta mine, researchers looked at changes in soil nutrient density and moisture content, as well as the effect of mining activities and plant type on characteristics at various phases of subsidence. According to the findings, soil density will increase developed in the arrangement *Officinalis ordosica>Pinus simonii>Solanum psammophila* prior to mines, with a negative link between preliminary and stable infiltration rates. There are no significant changes in soil particle size or water retention rate across plant species during extraction or three months following mining. The ground density also was in the sequence *Officinalis ordosica>S. psammophila>P.simonii* one year by mining, with such a negative association both with the constant infiltration rate and the constant infiltration rate. *Solanum psammophila, Officinalis simonii,* and *Lanceolata ordosica,* respectively, had water holding depths of 50 cm, 60 cm, and 30 cm. The Kostiakov equations were used to simulate the infiltration characteristics, and the anticipated and actual findings were comparable [5].

Jia-guo et al. investigated the influence of different seasons and rains on the amounts of nitrogen and phosphorus using various types of natural and anthropogenic sources in Dianchi Lake using UV spectrophotometry. In furthermore, the impacts of nitrogen and phosphorus to water pollution are investigated. The data demonstrated that during the rainy season, the environmental sedimentary rock nitrogen concentration in Dianchi Lake was normally low, but during the dry season, it was high. In atmospheric deposition, precipitation was shown to be positively related to nitrogen and phosphorus loading. The main seasonal variances were minimal in the summer months and large in the rainfall season. Soil solution nitrogen dominated the total nitrogen deposition load, accounting for 63.70% of its total nitrogen deposition load. The primary source of phosphorus was PP, which constituted for 45.54% of the total phosphorus precipitation load. The main sources of phosphorus and nitrogen in aerial moist deposition are improper fertilizing and nitrogenous compounds waste from fertilizers. The concentrations of TN and TP inside the natural and anthropogenic activities of Dianchi Lake were 6.14% and 12.76% of the river load, respectively, when combined alongside data form river discharges into the lake. As a consequence, the silt brought in by the river remained still the serious environmental problem in Dianchi Lake. However, as compared to other locations, the nitrogen and phosphorus fluxes in Dianchi Lake's natural and anthropogenic sources were intermediate; therefore this contribution needs to be examined further [6].

The influence of coal mining slump on infiltration into unsaturated soils in sand drift zones is explored utilizing a continuous injecting test with wetness front surveillance by Zang et al. in their research. The test is being carried out on two subsidence locations inside the southeast Mu Us Sandy Land's Bulianta mining industry that emerged in 2004 and 2005. In contrast to measurements on soil slopes, the findings show that at many lowlands sites with a sustained infiltration potential, higher length of wetting fronts may be noticed towards the end of the evaluation period. The average vertical flow rate and 175-minute infiltration thickness at the 2004 subsidence site with no cracks are significantly greater than measured values on the same soil slope in a control zone (P0.05). In the 2007 subsidence site with no cracks, the average lateral seepage rate is the same. The vertical infiltration rate in lowland regions climbs during first 10 minutes of both the test, then drops. The rate growth may be detected on soil slopes over the bulk of the test duration. The rate of lateral seepage infiltration, on the other hand, increases over first ten to twelve minutes before decreasing. The rate growth may be detected on soil slopes over the bulk of the test duration [7, 8].

METHODOLOGY

Design

This site's coal-bearing seam seems to have a medium cubic structure that is around 100 m deep. The completely automated long-arm mining technique is most often used in coal mining. The fully automated mining face has a length of 200–400 meters, a height of 5 meters, and a length of thousands and thousands of meters.) Between the operational faces, there seem to be 20-30 m diameter roadway coal pillars. As a consequence of huge fractures and stride fractures on just that area, as well as collapse pits, various types of mining damage, such as slumping, cracking, and bending, occurred in the underlying rock layers above the goaf. The highest strain ranges from 10 to 50 cm, whereas the deformation ranges from 0 cm to 80 cm. The coal seam is simple in design, as well as the coal rock is mostly semi dark coal. The operating facing coal seam is the bottom layer of a complicated coal seam; its coal beds are straightforward; and the coal is generally semi dark coal. This coal power plant is 6.0 m (4.2-10.0 m) thick on average. The lower coal seams fully automated caving face uses top coal caving technology, and the compounded area's upper sedimentary layer were excavated in 2002, with lower sedimentary layer being excavated currently. The working face has no distinguishing geological structure, and the coal beds have a simple structure.

Sample collection

Soil pH levels that are just too low or too high might stymie crop growth. Plant growth will be hampered by extremely corrosive soil structure, and also the resulting microelement poisoning. This occasion, the potentiometer measuring technique was utilized, and the instrument utilized was a pH meter. The influence of CO_2 injection just on pH of a soil environment may be calculated by monitoring the soil ph. Nitrogen is one of most critical nutritional components for plant development, and this is received and used by plants from the soil. The alkaline solution colorimetric method was employed to assess the soil's effective nitrogen concentration, and an alkaline burette was utilized as the experimental apparatus. The quantity of nitrogen that can be accessed in the soil reflects how much nitrogen will be available very soon. It has a direct relationship with crop development and is used to provide fertilizer recommendations. The amount of nitrogen accessible inside the earth is a minor part of the total nitrogen available. As particular, inorganic NH+ 4 makes up just 1% to 5% of total soil nitrogen. As a result, quantifying the amount of easily accessible nutrients such as nitrogen is essential for estimating soil fertility and assessing the influence of gas flow on soil health.

Potassium in the soil that is readily taken and used by vegetation, including such soil nutrient potash and soil exchangeable cations, is referred to as accessible potassium. One of the most significant markers of potassium availability in soil is available potassium, which would be a compound that seedlings may absorb and use directly. To estimate the amount of soil accessible potassium, Da used the NH4OAC removal photometer technique and atomic absorption spectroscopy. The amount of accessible potash may be used to calculate the impact of a high CO_2 concentration on soil potassium over a short period of time. The presence of water-soluble salt in saline alkaline soil is both a necessary trait and a crop growth hindrance. To some degree, it aids in the representation of the changing dynamics of soil salinization. An analytical balance, according to Tian, is the basic instrument. The dichromate volumetric method is used in this test, which employs the same apparatus as the moisture salt test. The impact of elevated CO_2 emissions on soil characteristics may be immediately detected by determining the quantity of soil organic carbon.

Instruments

Direct injection of ground liquid CO_2 method: Figure 1 depicts a flow of the system of the technique. A deep gob in the deeper coal seam is indeed the establishing effective for homogeneous liquid CO_2 injection. In the cutting whole area, earth water and electricity connection holes are used as drill holes. The borehole's surface serves as a location for system installation; the power distribution hole serves as a longitudinal CO_2 transmitting hole; as well as the 84 meter long low-temperature, high-pressure-resistant pipeline. An austenitic unibody design hose that has been welded together from a special process connects it to the side instrument and also the ground liquid CO_2 tank. An austenitic metal hose connects the bottom hole direct injection pipeline towards the end of both the floor straight pipe. The marten site metal hose is connected to the watching hole in the pipeline's ceiling, and the terminal is connected to something like a long automatic pneumatically device. Steel plates were installed with the help of arches and broadening screws. To guarantee safety, warning flags have been placed. A monitoring station, as well as 1,500 meters of distribution optical fibre to link machines in a ring network, is being built. A pipeline-pressure-holding device, a CO_2 monitor, and the surface and groundwater pipes from the converter to the public water drilling are all connected by the signal line. The signal line links the tension apparatus at the road terminal and is about 1200 meters long. As during intravenous administration of liquid CO_2, a secure emission flow rate of 300 m^3/min was estimated and implemented, taking into consideration the employer's safe CO_2 content restrictions. For 3 hours, gaseous CO_2 was pumped (14:00 to 17:00). There was a maximum of 60 t of injectable utilized. 17.1 × 20.97 t/h was the perfusion flow. It is predicted that the injection depth is about 140 meters.

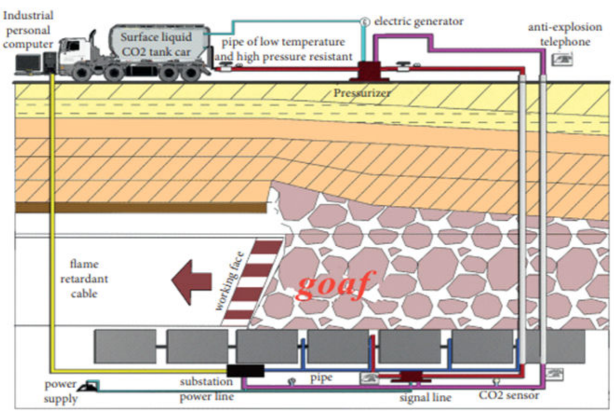

Figure 1: Ground liquid CO_2 direct injection process diagram.

Data collection

Each sampling point's location, depth, and amount of soil should be constant. Simply separate the sample from the debris and place it in a bag. Wet soil is used to keep and analyse the fresh samples. To clear up the waste, they cannot be stretched out for an extended period of time. They should be placed into a zip lock bag after passing through a 2 mm screen. At the sample site in each fissure, an undisturbed soil drill (length 1 m, diameter 50 mm) is used to dig a 1 m deep soil cylindrical pit. The soil samples are then put into fabric and zip lock bags using a drill bit to spin the dirt. The cloth bags containing the samples are returned inside to dry naturally. The zip lock bag is kept cool in the lab using an ice bag before being frozen and preserved for later soil index determination and analysis.

Data analysis

Samples taken which have been air-dried inside the field are collected. The data till they have spontaneously dried inside the shade in a clean, well-ventilated facility. The drying time should be between 3 and 5 days. Sun exposure is strictly prohibited, and polluting factors such as acid, alkali, dust, gas, as well as other pollutants that may affect test results should be taken into account. Soil samples must be moved on a frequent basis throughout the air-drying process, large soil blocks must be pulverized, and non-soil intrusions including such pebbles must be eliminated. Returning air-dried soil samples to the laboratory, they were maintained at 25°C till they were presented to the test will tell.

RESULTS AND DISCUSSION

Soil pH analysis

Under typical conditions, the pH of the soil ranges between 4 and 9, preventing plants from carrying out their regular metabolism and preventing them from absorbing and transporting nutrients. Plant roots may be absorbed and used effectively in a soil environment with a neutral pH value. However, in alkaline soil medium, several elements including Fe, Mn, and Cu are difficult to utilize.

The pH has an impact on the kind and number of current bacteria in the soil. The pH value of four air-dried samples fell on average by 0.046, whereas the value of one sample rose. Four new samples saw their pH values decrease by 0.15 on average, while one sample had an increase. P4 levels were greater across both space and fresh specimens, indicating that soil heterogeneity had an impact. The pH decreases for the very first time after CO_2 is administered. Because CO_2 comes in contact with water, it ionizes plasma and produces additional H+ and Bicarbonates in the soil. The pH increases during the second test and then falls between first and subsequent detection levels, demonstrating that CO_2 causes the pH to decrease in the short term. The pH value will ultimately return to its previous value due to the short period of the CO_2 atmosphere. As a consequence, CO_2 may reduce the pH of the soil to varying degrees. The distinction among air-dried and fresh variations in terms of quantity and shifting trend is generally negligible. This shows that CO_2 injection decreases soil pH in a brief span of time, with no discernible pH change pattern across study locations. As a consequence, increasing CO_2 levels in the soil has a little influence on its pH [9].

Since the study monitoring soil carbon in coal mining areas is still limited, the research aim should include not only injecting the weaker soil inside the topsoil layer directly above the soil specimen, but also selecting the more rich soil as a comparative soil sample. As a consequence, three soil samples were taken on the surface of the area in which the liquid carbon dioxide was pumped in the forest zone (labeled C1, C2, and C3) as points of comparison. Specimens and space soil samples should be used to examine the mechanical/chemical features of the contrast samples.

CONCLUSION

The samples were examined before and after the CO_2 injection and the findings were assessed. The following is a summary of the findings:

- It is anticipated to quickly revert to its original value with little effect.
- CO_2 injection raises the functional nitrogen content of wind and fresh samples collected, improving soil health for a brief time but rapidly reverting to its initial amount.
- Inside the near future, it is expected to revert to its previous value with a modest rise.

After CO_2 infusion, organic material carbon in air-dried samples decreased, whereas fresh samples increased. The available organic content of the exhibits changed significantly as compared to the air-dried samples, and indeed the richness increased, which was helpful to plant development.

Nevertheless, the revenue is estimated to swiftly return to its previous level, and the impact period will be limited. In general, CO_2 injection has little effect on soil chemistry. The pH level, for instance, which is unfavorable to plant growth, dropped somewhat but quickly recovered. Thus according latest thinking and combined test data, CO_2 injection in the goaf has a particular influence on the chemical features of the underlying ground, as well as a supportive effect on plant growth. When liquid CO_2 was introduced into the soil, it was unable to induce substantial changes because the pH was rebalanced by an organic buffer system on the inside of the soil.

REFERENCES

1. Ritchie JC, McCarty GW, Venteris ER, et al. Soil and soil organic carbon redistribution on the landscape. Geomorphology. 2007;47:763-771.
2. Ohno T, Fernandez IJ, Hiradate S, et al. Effects of soil acidification and forest type on water soluble soil organic matter properties. Geoderma. 2007;71:1394-1404.
3. Lu D, Li C, Sokolwski E, et al. Crop yield and soil available potassium changes as affected by potassium rate in rice–wheat systems. F Crop Res. 2017;214:38-44.
4. Barton D, Gammack SM, Billett MF, et al. Sulphate adsorption and acidification of Calluna heathland and Scots pine forest podzol soils in north-east Scotland. For Ecol Manag.1999;114: 151-164.
5. Bi Y, Zou H, Zhu C. Dynamic monitoring of soil bulk density and infiltration rate during coal mining in sandy land with different vegetation. Int J Coal Sci Technol. 2014;1:198–206.

6. Ren JG, .Characteristics of nitrogen and phosphorus formation in atmospheric deposition in dianchi lake and their contributions to lake loading. Huanjing Kexue/Environmental Sci. 2019;40:582-589.
7. Zang YT, et al. Effects of coal mining subsidence on infiltration into unsaturated soils in sand drift areas. Shuikexue Jinzhan/Advances Water Sci. 2012;23:757-767.
8. Monokrousos N, Papatheodorou EM, Orfanoudakis M, et al. The effects of plant type, AMF inoculation and water regime on rhizosphere microbial communities. Eur J Soil Sci. 2020;71:265-278.
9. Nordin A, Högberg P, Näsholm T. Soil nitrogen form and plant nitrogen uptake along a boreal forest productivity gradient. Oecologia. 2001;129:125–132.
10. Haling RE, Simpson RJ, Culvenor RA, et al. Effect of soil acidity, soil strength and macropores on root growth and morphology of perennial grass species differing in acid-soil resistance. Plant Cell Environ. 2011.