SMART SOLIDS CONTROL SYSTEM

This application is a continuation-in-part of U.S. Application No. 16/931,242, filed July 16, 2020, which itself claims priority to the July 16, 2019 filing date of U.S. Provisional Application No. 62/874,853. This application also claims priority to the February 1, 2023 filing date of U.S. Provisional Patent Application No. 63/442,740. The contents of all of the foregoing applications are incorporated herein by reference.

BACKGROUND

[0001] The invention relates to systems and methods for identifying when actual problems are occurring in a drilling operation, or when conditions indicate that a potential future problem may arise in a well drilling operation.

[0002] In the past, well drilling operators were provided with some guidelines or algorithms that could be used to determine when a well drilling problem has arisen or when a potential problem might soon arise. The input to those guidelines and algorithms typically included data relating to the drilling rig itself, such as rotational speed, pressure on the drill bit and various other parameters. The input to the guidelines and algorithms sometimes also included general observations made regarding the quantity and quality of the cuttings or material being pumped out of the well as drilling operations occur.

[0003] The point of comparing drilling operations to the cuttings and material arriving at the surface is to determine if an anomalous or problem condition has occurred or is soon likely to occur. If the cuttings and material arriving at the surface do not correlate well to the drilling operations, this can be an indication that there is a problem with the well drilling operations.

[0004] Because of the delay that occurs between when a drill bit cuts material at the bottom of the well and when that material arrives at the surface, it is often difficult to correlate the cuttings and material arriving at the surface when the drilling operations that occurred when the cuttings were made. Also, it can be difficult for well drilling operators to make reliable judgments about the quantity and quality of the material and cuttings leaving the well. These factors, together, make it difficult to correlate the well drilling operations that give rise to certain cuttings and material and the actual cuttings and material arriving at the surface.

SUMMARY

[0004a] In a first aspect, the present disclosure refers to a method for determining when an abnormal condition in a well drilling operation may have occurred or may soon occur, the method comprising: receiving drilling operation data from a well drilling rig that is indicative of when one or more well drilling operations occurred during the drilling of a well; receiving condition data that is indicative of at least one condition being experienced by a material separation system that processes cuttings generated by the well drilling rig to separate solids from well drilling fluid; analyzing the condition data to determine when the condition data appears to indicate the occurrence of a first drilling operation and to determine a predicted point in time at which the first drilling operation would have occurred; determining whether the drilling operation data indicates that a drilling operation corresponding to the first drilling operation identified in the analyzing step occurred approximately at the predicted point in time; and causing an alert to be issued when the determining step indicates a drilling operation corresponding to the first drilling operation did not occur approximately at the predicted point in time.

[0004b] In a second aspect, the present disclosure refers to a method for determining when an abnormal condition in a well drilling operation may have occurred or may soon occur, the method comprising: receiving drilling operation data from a well drilling rig that is indicative of when one or more drilling operations occurred during the drilling of a well; receiving condition data that is indicative of at least one condition being experienced by a material separation system that processes cuttings generated by the well drilling rig to separate solids from well drilling fluid; analyzing the drilling operation data to identify the occurrence of a first drilling operation and to predict a point in time when a change in at least one condition being experienced by the material separation system would likely occur due to the occurrence of the first drilling operation; analyzing the condition data to determine whether a change in at least one condition being experienced by the material separation system occurred at approximately the predicted point in time; and causing an alert to be issued when the analysis of the condition data indicates that there was not a change in at least one condition being experienced by the material separation system at approximately the predicted point in time that corresponds to the first drilling operation.

[0004c] In a third aspect, the present disclosure refers to a system for determining when an abnormal condition in a well drilling operation may have occurred or may soon occur, comprising: at least one sensor that is configured to report data indicative of a condition being experienced by a material separation system that processes drilling cuttings from a well drilling operation; and a data trend analyzer that receives drilling operation data from a well drilling rig that is indicative of when one or more well drilling operations occurred and that receives condition data from the at least one sensor, wherein the data trend analyzer is configured to: analyze the condition data to determine when the condition data appears to indicate the occurrence of a first drilling operation and to determine a predicted point in time at which the first drilling operation would have occurred; determine whether the drilling operation data indicates that a drilling operation corresponding to the first drilling operation identified in the analyzing step occurred approximately at the predicted point in time; and cause an alert to be issued when the determining step indicates a drilling operation corresponding to the first drilling operation did not occur approximately at the predicted point in time.

[0004d] In a fourth aspect, the present disclosure refers to a system for determining when an abnormal condition in a well drilling operation may have occurred or may soon occur, comprising: at least one sensor that is configured to report data indicative of a condition being experienced by a material separation system that processes drilling cuttings from a well drilling operation; and a data trend analyzer that receives drilling operation data from a well drilling rig that is indicative of when one or more well drilling operations occurred and that receives condition data from the at least one sensor, wherein the data trend analyzer is configured to: analyze the drilling operation data to identify the occurrence of a first drilling operation; predict a point in time when a change in at least one condition being experienced by the material separation system would likely occur due to the occurrence of the first drilling operation; analyze the condition data reported by the at least one sensor to determine whether a change in at least one condition being experienced by the material separation system occurred at approximately the predicted point in time; and cause an alert to be issued when the analysis of the condition data indicates that there was not a change in at least one condition being experienced by the material separation system at approximately the predicted point in time that corresponds to the first drilling operation.